THE GEOGRAPHICAL REVIEW

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Separate Maps published in the *Geographical Review* and the *Bulletin of the American Geographical Society*, the majority in color. 25 cents each. A list will be sent upon request.

THE GEOGRAPHICAL REVIEW

VOL. XIX JULY, 1929 No. 3

THE WILKINS-HEARST ANTARCTIC EXPEDITION, 1928–1929

Captain Sir Hubert Wilkins

[With separate map, Pl. IV, facing p. 374]

MY first visit to the Antarctic was made in 1920. In that year I went south to Deception Island and there came to know the sterling qualities of the captains and managers of the Norwegian whaling companies. The original aim of the expedition to which I was attached[1] was to survey the King Edward VII Land area and reach the south pole by airplane. We had a vessel almost completely fitted and twelve airplanes—a gift from the Royal Air Force Disposal Board, old war-time stock which we intended to use in relays, abandoning more than half of them en route. However, the hoped-for support failed, and the main objective of the expedition had to be abandoned. We changed our plans and decided to try to reach the Graham Land plateau and with dog teams journey as far south as possible. The airplanes were returned to the air force, and finally a party of four with a twenty-eight-foot lifeboat, seven dogs, two sled boats of special design, and ample food and equipment for two years were landed, through the courtesy of the Norwegian whalers, at a small island in Andvord Bay on the western shore of Graham Land (lat. 64° 48′ S.). It was evident from observations made in De Gerlache Strait that our dogs would be worthless. From a distance we could see the level top of Graham Land faced with sheer precipitous cliffs several hundred feet high. Our only hope was to carry the dogs and our supplies on our backs to the plateau and then make a quick dash southwards—a forlorn hope and one never realized. We maintained our base on a little penguin-covered island. With our lifeboat we traveled several hundred miles

[1] This was the British Imperial Antarctic Expedition under J. L. Cope as leader.

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FIG. 1

FIG. 2

FIG. 3

FIG. 1—The *Hektoria* with the small whale catchers in Bransfield Strait. (All photographs illustrating this article are copyright by the *New York American* and Universal Service.)

FIG. 2—Thin and scattered ice in Deception Harbor.

FIG. 3—The bird life, which practically covered the harbor, was a serious menace to the seaplanes.

up and down the coast, surveying about thirty miles of new coast line. It was obvious that aircraft would be necessary to carry out a survey of Graham Land; and the expedition was disbanded, though two members decided to stay over the winter season.[2]

I came back to New York and managed to persuade the agent for the Junker monoplane to put two machines at my disposal for Antarctic exploration. The plan for 1921–1922 was to accompany the Norwegian whalers to Port Lockroy, near Antwerp Island, and from there make flights in seaplanes as far as possible with the machines available. The provisos attached to the gift, however, threatened the possibility of delay beyond the time for connecting with the whalers at Montevideo in September. At this time Sir Ernest Shackleton was making preparations for his Antarctic expedition in the *Quest*. He opened negotiations and finally persuaded me to postpone my plan and join him on his expedition, during which we might fly not only at Graham Land but at other points along the Antarctic coast line. The *Quest* car-

[2] M. C. Lester: An Expedition to Graham Land, 1920–1922, *Geogr. Journ.*, Vol. 62, 1923, pp. 174–194.

ried our airplane part of the way, but with other of our polar stores it was left at the Cape Town depot. A series of delays prevented us from collecting the machine before we went into Antarctic waters. Our experience throughout the three months (January–March, 1922) in the Antarctic served to confirm my belief that airplanes could be used successfully throughout an Antarctic summer.

The Expedition Reaches Its Base

On my return from the Point Barrow-Spitsbergen flight in the spring of 1928 I began preparations for the Wilkins-Hearst Antarctic Expedition. The American Geographical Society sponsored the enterprise. The many acknowledgments due for support of the expedition are made in the appendix to this report. The main equipment comprised the Lockheed Vega monoplane used on the Arctic flight and a duplicate machine. Our staff consisted of Lieutenant Carl Ben Eielson, my companion and pilot on many flights, Pilot Joe Crosson of Alaskan fame, and Engineer Orval Porter, who had accompanied me to the Arctic in 1926. We left

Fig. 4

Fig. 5

Fig. 6

Fig. 4—A penguin rookery on the steep slopes of Deception Island.

Fig. 5—The landing field on Deception Island (compare Fig. 7). The runway is indicated here and on Figure 38 by a white line.

Fig. 6—The Lockheed Vega monoplane *San Francisco*, in which our long flights were made.

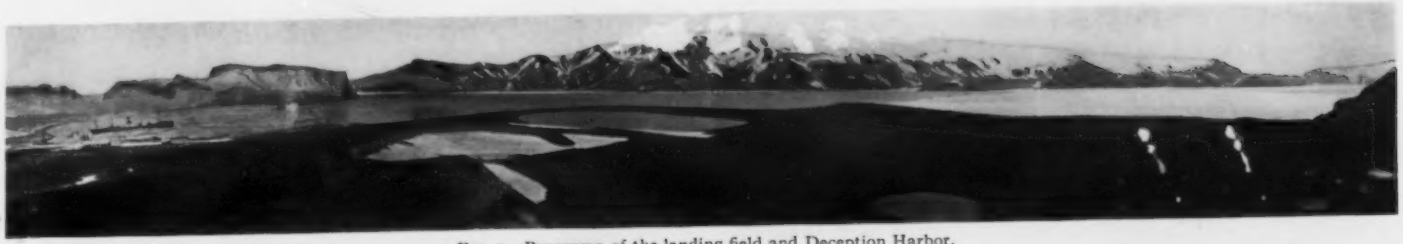


FIG. 7—Panorama of the landing field and Deception Harbor.

FIG. 8—The landlocked harbor of Deception Island.

FIG. 9—Bransfield Strait, Graham Land, and Brabant Island.

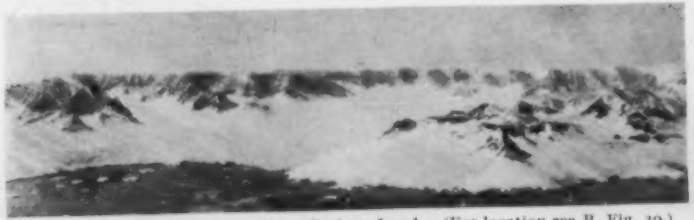


FIG. 10—Brialmont Bay, northern Graham Land. (For location see B, Fig. 39.)

FIG. 11—Salvesen Bay, northern Graham Land. (For location see C, Fig. 39.)

New York on September 22 and made a comfortable and uneventful journey to Montevideo, at which place I obtained the services of Victor Olsen, radio operator. At Montevideo our two planes, set up in flying order, and the other paraphernalia were loaded on board the *Hektoria*, a ship of 15,000 tons register. We were most comfortably accommodated. Our journey to the Falkland Islands was uneventful. At that place I received from His Majesty's Government authority to claim new lands and territories for the British Empire.

Soon after leaving the Falkland Islands we met with snowstorms, high winds and rough seas, and, as we approached the ice, with fog. The small catchers went out ahead to act as a vanguard. Our course took us between King George Island and Elephant Island, and as we entered Bransfield Strait we met with scattered ice and an occasional berg. Bransfield Strait was loosely filled with ice, but it offered no barrier to our progress. We entered Deception on November 6 to find the ice thin and scattered and the land but lightly covered with winter snow. In fact much of the land was bare, and whalers who had visited Deception Island every year for the last fourteen years proclaimed it to be an unusual season. The *Hektoria* was moored stern to the beach with her decks but a few yards from the shore. A gangplank was run out from the land, and we had free access to and from the boat. On November 10 we unloaded the seaplane that Ellsworth and I had used on our Arctic flight. It made further history as the first complete airplane to touch Antarctic soil: Sir Douglas Mawson, it may be noted, had landed an airplane fuselage minus wings at Adelie Land in 1913.

Trial Flights

While Deception Harbor in the vicinity of the ship and shore station was free from ice when we arrived, the bay, seven miles deep and five miles across, was in November covered with smooth flat ice. Records show that for fourteen years this bay ice remained firm and solid until about Christmas Day. As a rule it is about six or seven feet thick when the whalers arrive, and it was upon the dependableness of this ice that I had based my scheme of operations. I planned to use skis, make a flight to reconnoiter Weddell Sea, select a more southerly base, and then when conditions were favorable take the two planes, alight some five or six hundred miles south of Deception, and with one plane reloaded fly on along the coast to the Ross Sea Barrier. It was believed that the period between the fifteenth and the twentieth of December would be the best for this work. The second machine would of course return to Deception Island. We examined the flat bay ice and much to our consternation found it not more than two feet thick. The mildness of the season or the warmth from the volcanically influenced beaches surrounding it had melted

Fig. 10—Brialmont Bay, northern Graham Land. (For location see B, Fig. 39.)

Fig. 11—Salvesen Bay, northern Graham Land. (For location see C, Fig. 39.)

the ice at its edges and honeycombed it in the center. A violent storm might possibly break it up at any moment. Obviously it was unsafe to leave our machine unattended upon its surface.

The small amount of snow on the flat-surfaced land was fast disappearing. There seemed to be one place from which we could fly the machines with skis from the land to the bay ice when the weather was fine, and from the sea ice we hoped to take off for our preliminary flights. Accordingly we fitted skis to our planes and waited upon the weather. Extraordinary weather came but not of the kind hoped for! Rain and high temperatures continued for several days, and the snow disappeared. Water six to eight inches deep formed on the flat ice in the harbor. We were compelled to change our skis for wheels, and we cleared a short runway on a hillside where the volcanic tuff and lava were fairly level.

Cloudy weather prevailed, but on November 16 we essayed the first flight ever made in the Antarctic and looked down through the clouds upon the runway we had built across the small peninsula on the western side of the whalers' anchorage.

No longer flight, however, could be attempted until November 26, when our two machines went in opposite directions seeking a better field from which to make a start. We flew over the landlocked harbor at Deception Island. The neighboring islands except two, Low and Snow, were high and mountainous. The low-lying ones were covered with deep snow, badly crevassed. On the others, including Livingston Island, the mountains rose to 6000 feet almost sheer from the sea. We flew for several hours about the cloud-engirdled mountains; then, as the midnight sun was sinking to its lowest level, we followed the shadowed coast to our base.

We had not found a place elsewhere that would serve our purpose, and so we carefully tested the bay ice at Deception and decided one cold clear morning to risk a landing on it. This nearly brought disaster. The machine landed safely but ran far beyond the three-hundred-yard area we had tested into a soft patch in the ice and fell through. The wings and fuselage held it from disappearing beneath the water. Eielson, who was piloting, climbed out unhurt; and with the help of twenty whalers and after several hours of difficult and extremely dangerous work we managed to raise the machine and drag it to a safe place on the ice. Next day we attached the pontoons and brought the machine back to the beaching place near the ship and factory.

The machine was none the worse for its wetting, and we made many tests of it as a seaplane, always with the hazard of the sea birds in the harbor. Birds were attracted in millions by the activities of the whaling factory on the shore. Pilot Crosson, who has had much experience with seaplanes and who carried out these flights, showed

FIG. 12

FIG. 13

FIG. 14

FIG. 12—The glacier on Mt. Pond, Deception Island: the only glacier on the island which "truly merits the name."

FIG. 13—Banded ice and ashes of the Mt. Pond glacier on Deception Island.

FIG. 14—Snow Island, low-lying and covered with deep, crevassed snow.

much courage and skill. Although we struck and killed several birds our machine was never out of control nor badly damaged. It soon became evident, however, that our only chance of doing anything from Deception Island that season lay in using the machines as land planes. It would be necessary to extend the runway on the land and go south on wheels. To make a runway half a mile long—the distance across the peninsula—through the mounds of lava that resembled piles of large-sized coke, looked at first like an impossibility. With courage born of necessity we started the job and with hands, wheelbarrows, buckets, rakes, and shovels, cleared many tons of débris and had at last a runway forty feet wide and about two thousand five hundred feet long. It had two bends in it of about twenty degrees, and the surface was soft and cindery.

A forced landing anywhere throughout the journey would mean disaster. The greatest danger, however, lay in the take-off; the greatest difficulty for the pilot was to handle the heavily laden machine on the soft-surfaced runway. But something worse threatened. The weather could not be depended upon after December. Hence, relying on Eielson's ability to control the machine and providing as far as possible for any emergency, we loaded two hundred gallons of gasoline into the tanks, filled our packs with our spare clothes, equipment, and food consisting of biscuits, pemmican, chocolate, nuts, raisins, and malted milk sufficient for thirty days on a twelve-ounce-per-day diet. There was ample room for our packs and alpine climbing gear in the cabin of the plane. Each man's equipment was separate and intact. It could be seized and swung upon our backs at a moment's notice or discarded with equal facility. In case of accident and a forced march home we should each have our own supply if one or the other happened to go through a crevasse. To each man's alpine rope was attached a pole and a small strong block and tackle with which he could, if uninjured, haul himself up the rope in a vertical position.

Over Northern Graham Land

On the morning of December 20 the weather was perfect, just a little wind, a clear sky, and sparkling atmosphere. The thermometer on the ground stood at about 38° F., a tolerable temperature except when we were working in our warm Worumba clothes: then we were uncomfortably warm.

At 8.20 a. m. we were in the air heading south. The hazardous take-off had been, with Eielson's skill and courage, successfully accomplished. We directed our course a little west of south, taking the peak of Trinity Island as a landmark. Once in the air our machine functioned perfectly, the engine seeming faultless. Even though we were climbing, our ground speed averaged more than 125 miles

FIG. 15

FIG. 16

FIG. 17

FIGS. 15, 16, 17—Livingston Island as seen during our preliminary flights in search of a better landing field than that afforded by Deception Island. This mountainous ice-clad island, however, offers no possibilities to the aviator.

FIG. 18

FIG. 19

FIG. 20

FIG. 18—Trinity Island, showing table-topped Graham Land in the distance. (For location see A, Fig. 39.)

FIG. 19—Detroit Aviation Society Plateau. (For location see D, Fig. 39.)

FIG. 20—The east coast of Graham Land showing the Seal Nunataks in the distance. (For location see E, Fig. 39.)

FIG. 21

FIG. 22

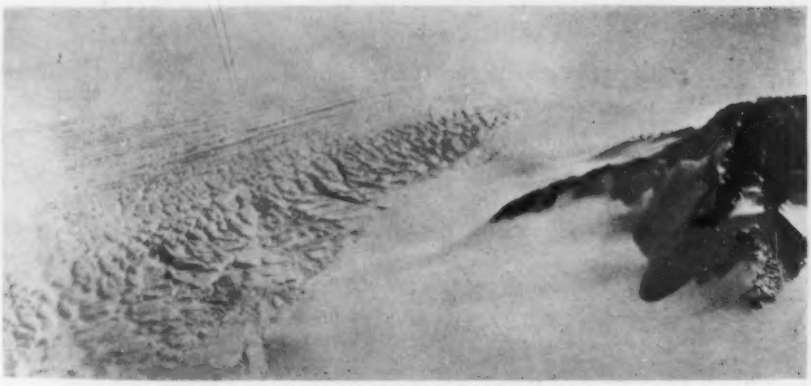


FIG. 23

FIG. 21—Hektoria Fiords, long ice-filled fiords almost severing Graham Land. (For location see F, Fig. 39.)

FIGS. 22 and 23—Crevasses on the Nordenskjöld Shelf Ice in the neighborhood of Drygalski Bay. (For location of Fig. 23 see G, Fig. 39.)

per hour. By 8.40 we were at 6000 feet altitude and beside Trinity Island. The plateau of Graham Land, which we could see beyond the island, was marked on our charts "from four to six thousand feet" altitude. At 6000 feet we were beneath its level, so we swerved westward while climbing. We passed Brialmont Bay. At Salvesen Bay, a few miles farther south, we turned and at 8200 feet decided to cross the plateau which we named Detroit Aviation Society Plateau.[3] As far as we could see to the eastward the Graham Land plateau continued. We were above it at 9.50, and for a few minutes we flew due south. To the east we could see the Seal Nunataks and Robertson Island.

Far away to the southeast we could see "water sky" but not much of it, nor was it very distinct. To the west were long ice-filled fiords almost severing Graham Land. These, named Hektoria Fiords, were not photographed until we were on our homeward journey. They are entered from the indentation named Drygalski Bay by Nordenskjöld. We were now flying above ice in Weddell Sea, the Nordenskjöld Shelf Ice. The surface beneath us was broken by huge crevasses into which our machine could have fallen and left no trace. These crevasses, "broad, bottomless, yawning, blue abysses" as Nordenskjöld has described them,[4] were numerous only near the land. At 10 a.m. I noted in my diary: "There appears to be a haze or a very low cloud ahead [we were flying at 8000 feet], or perhaps it is wind which over the Arctic pack ice I know from experience is indicated by milk-white sky upon the horizon." Later an entry reads: "Four hours out. Just struck the first bumpy air experienced today." We had come to the wind we had seen some hours before.

At ten o'clock we were opposite a deep inlet, Evans Inlet, which appeared at first to cut right through Graham Land. In fact I actually made a note to that effect in my log but corrected it later when we could see the mountains at the end of the level ice. Opposite Jason Land was a deep indentation which also threatened to sever the north of Graham Land but which again did not reach quite through. This apparently is Nordenskjöld's Richthofen Valley.[5] The north side of the inlet we called Cape Fritsche, and the south side Cape McCarroll. From there the land trended southwestward in a series of rugged mountains.

On our way south we passed between C. A. Larsen's "Foyn Land" and the coast and saw two conspicuous black mountains which we

[3] We named the various places discovered with the view of recommending that a committee of geographers, to be appointed by the American Geographical Society, approve of them. See appendix.

[4] Otto Nordenskjöld and J. G. Andersson: Antarctica, or Two Years Amongst the Ice of the South Pole, London and New York, 1905, p. 221. See also references to fissure zones on pp. 226 and 228. See also the description of the Shelf Ice in the scientific results: Otto Nordenskjöld: Die Expedition und ihre geographische Tätigheit (Wissenschaftliche Ergebnisse der Schwedischen Südpolar Expedition 1901–1903, Vol. 1, No. 1), Stockholm, 1920, pp. 158–168.

[5] Nordenskjöld and Andersson, Antarctica, p. 225.

FIG. 24

FIG. 25

FIG. 26

FIG. 24—Looking from Cape McCarroll toward the end of northern Graham Land. (For location see H, Fig. 39.)

FIG. 25—Mt. Napier Birks. (For location see I, Fig. 39.)

FIG. 26—Crane Channel and Foyn Island. (For location see J, Fig. 39.)

named Mt. Napier Birks. Just south of there we saw what we believe to be a circuitous channel dividing Graham Land. It was not photographed until our homeward journey and when we were outside Foyn Island. It was named Crane Channel.

FIG. 27—Lockheed Mountains near Cape Northrop. (For location see K, Fig. 39.)

OVER SOUTH GRAHAM LAND

South of Crane Channel we came near to the coast. I noted in my log that some of the peaks were of stratified material. The entry reads: "The islands have cliffs at their southern sides. The steepest exposures on the mountains face south. The strata in some instances dip north at 45°. There are some black seams showing; perhaps they are coal. Notice three seams here one above the other about a hundred feet apart." That was about latitude 67°. A mighty mass of mountains stretched far to the southwestward from Crane Channel, and opposite was an island not marked on the chart until we named it Robinson Island. The most easterly point of the large island, which we concluded was South Graham Land, we called Cape Northrop; and the mountains we named Lockheed Mountains. From there a bay, Mobiloil Bay, extended deeply towards the west. In the middle of it was a sharp indentation. When crossing it we felt, for the first time that day, a disturbance in the atmosphere. The mountains flanking the northern half of the bay were deeply scarred with four huge glaciers, which we named Whirlwind Glaciers. The coast, which lies farther south than Nordenskjöld or Larsen had been and is opposite Fallières Coast, we named Bowman Coast. In the middle of the bay away from the land the shelf ice looked smooth as a billiard table, but as we approached the coast again at the southern end of

the bay the ice became so badly broken that it would be impossible, I believe, to walk across it. On the way back we saw indications of low islands. By 12.32 we were opposite high steep mountains, one of which we named Mt. Ranck, and these seemed to terminate the

FIG. 28—Cape Mayo (left), Casey Channel, Mt. Ranck, and Cape Keeler. (For location see M, Fig. 39.)

second part of Graham Land. A channel, which narrowed in its center but appeared to hold only level ice, widened again; and we felt sure that the ice in the channel rests on land below sea level. We named it Casey Channel, and the island south of it Scripps Island.

STEFANSSON STRAIT AND HEARST LAND

South of South Graham Land the mountains are not generally as precipitous as on the more northerly islands. Scripps Island is about thirty miles wide. At 12.50 I noted in my log "We are now quite certain that Graham Land is not connected with the mainland continent." We felt sure of this before, but at this point it could be distinctly shown in a photograph. We named the cape at the northern side of that channel Cape Walcott, the channel Lurabee Channel, and the islands to the south the Finley Islands. In a few minutes we could see that the group of islands did not extend very far. They were divided by level, smooth ice. There appeared to be a group of six or more of these islands scattered in a wide strait. We could not clearly define their outlines because we were then flying at two thousand feet, to which height we had descended for observation of the snow surface. Beyond the islands extended a level strait; and farther south a smooth slope, wide and unbroken, reached southward. It was not marked by

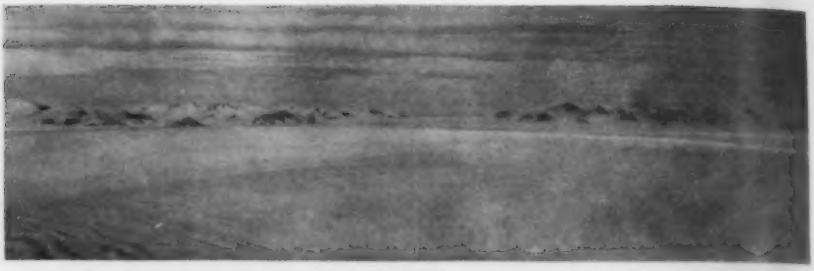


FIG. 29

FIG. 30

FIG. 31

FIG. 29—Mobiloil Bay and Bowman Coast. (For location see L, Fig. 39.)
FIG. 30—Lurabee Channel between Cape Walcott, Scripps Island (right), and the Finley Islands. (For location see N, Fig. 39.)
FIG. 31—The Finley Islands looking toward Lurabee Channel and Scripps Island. (For location see O, Fig. 39.)

even a speck or shadow and would not show on a photograph. We called the strait Stefansson Strait, and the land beyond it Hearst Land.

The edge of Hearst Land, which we believe to be part of the great Antarctic continent, was distinguishable to the eye by a comparatively low ice cliff, which, because of the angle of the sun, failed to show distinctly in the photograph. And unfortunately at this important point I had difficulty with the camera. To the eastward the edge of the mainland was marked with a few small, low nunataks about a cape which I called Cape Eielson; and from there the low ice cliff swung slightly southward. Far beyond to the eastward, in the dim

FIG. 32

FIG. 33

FIG. 34

FIG. 32—The Finley Islands and Stefansson Strait. (For location see P, Fig. 39.)
FIG. 33—Stefansson Strait and Hearst Land. (For location see Q, Fig. 39.)
FIG. 34—Looking northeast over Hearst Land from about lat. 70° 45′ S., long. 64° W. The edge of the mainland is marked by a few small nunataks (Cape Eielson) and a low ice cliff. (For location see R, Fig. 39.)

distance, too far to show on a photograph, I could see huge tabular icebergs standing up above the level of the surrounding ice and concluded that they must have been at one time or were even then afloat.

When we reached a point estimated to be about latitude 71° 20′ S., longitude 64° 15′ W., we had used nearly half our supply of gasoline. We had ascertained that we might land with skis almost anywhere in that vicinity and had proved to our satisfaction that Graham Land was not part of the continental area. Storm clouds that we had seen developing behind us threatened to cut us off from our base; and so with the idea of returning safely with the information gathered we swung our airplane to face the north and hurried homewards.

FIG. 35—Storm clouds developing over Graham Land.

THE RETURN FLIGHT

Meteorological conditions became interesting. Three cloud areas were developing. One was to the west of us in the southern Pacific Ocean; a lesser one in Belgica Strait, halfway back to our base; and, as we traveled farther north, low in the distance another storm area could be seen developing west of Deception. Before we were halfway back we felt the influence of the wind. First it was from the south, then from the east, and then we entered a calm belt. As we neared Deception we met northwest wind and with it cloud. To the south in De Gerlache Strait the sun, reflected in the sea, illumined Brabant Island and the coast of Graham Land. Ahead the clouds were almost solid and, streaming out, hid Deception Island from our view. We kept a compass course and when nearing the island caught a glimpse of its coast.

From 5000 feet above we saw through a hole in the clouds our landing field, and Eielson threw the machine into a sharp spiral nose dive and landed safely within ten hours of the time we started. Our ground speed on the return trip, helped a little by a wind behind us, averaged more than 130 miles per hour. All through the day until we descended at Deception Island the temperature in the cabin of the plane was never below 64° F. When we descended we began to feel the cold. The temperature had been warmer at higher altitudes, but we were no doubt more susceptible to the cold at the end of the journey. We had been working hard for many hours before the actual start of the flight, and for ten hours we had flown through conditions of absorbing interest.

An Exceptional Season

During the first part of the flight we passed over country from which so much snow had melted that it was not possible to judge anything with regard to the winter snowfall. At the north end of the Nordenskjöld Shelf Ice we were at such high altitudes that the snowdrifts were not conspicuous. Nearing the most southerly point on our flight we noticed that the drifts had been formed when the wind was from the north and that across these were drifts formed in a westerly wind.

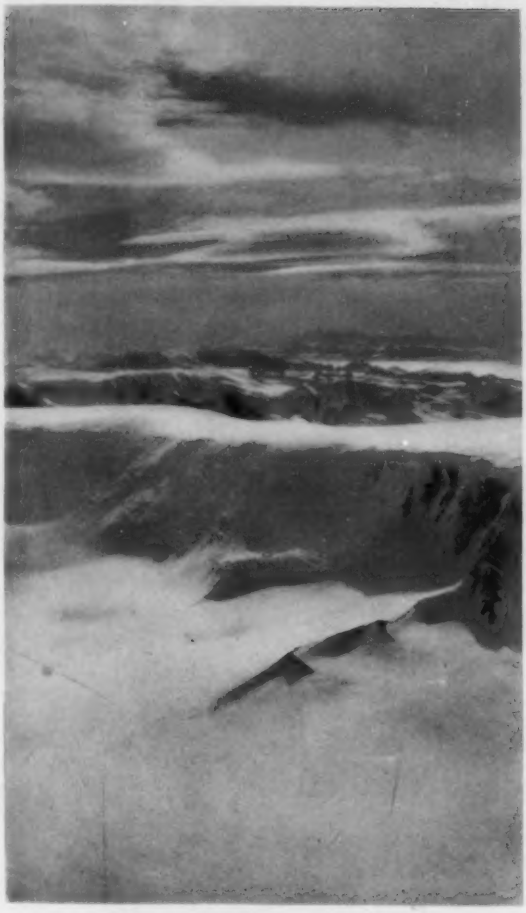


Fig. 36—Clouds over De Gerlache Strait.

On January 10 we made a second long flight over Graham Land—250 miles out on more or less the same course—and confirmed the observations made on our first flight. We could not, however, expect to get off with a greater load than we had carried on our first long flight, and it was deemed advisable to postpone further effort until next season. By going south early in the season we can expect to use the ice in the harbor at Deception Island. We believe it is possible to make landings on the shelf ice with skis. We propose to fly to a point five or six hundred miles south of Deception and there await the favorable time to cross to the Ross Sea. The N. Bugge Hektor Whaling Company has generously agreed to carry us again next season to Deception Island, where our machines and supplies are stored in a warehouse. We are expected to be ready to join the boat at Montevideo some time next September.

Everything except the earliness of the season was as we expected to find it in the Antarctic. The season was no doubt three weeks or a month earlier than normal, and little snow had fallen throughout the

preceding winter. Another disappointment was the fact that a spare whale catcher, which is for use only in emergency and is the customary equipment of the Hektor Company at Deception Island, could not this year accompany us. I had planned to hire the spare catcher if necessary to help us in our work. It was not available; and it was not advisable from any point of view to hire at great expense a "working" catcher upon which the whole crew of the Company were dependent for their livelihood. The boat-for-hire problem will be solved next season, I hope, through arrangement with the Governor of the Falk-

FIG. 37—Looking down from 5000 feet to the landing field on Deception Island.

land Islands Dependencies, who has promised to recommend that the Hektor Whaling Company be licensed to use an extra catcher with the understanding that it will be placed at my disposal if necessary. This is an arrangement to which I believe the Company will be agreeable.

APPENDIX

EDITORIAL NOTE ON THE HISTORY OF DECEPTION ISLAND

Deception Island, a sea-breached crater, early excited interest as a "curious phenomenon of nature," as Fanning says in his "Voyages Round the World" (1833), and the best harbor in the South Shetlands. The actual discovery and naming of the island are obscure. Mr. Edwin Swift Balch, in an article "Stonington Antarctic Explorers" in the *Bulletin of the American Geographical Society* (Vol. 41, 1909, pp. 473–492), gives the romantic account of the first American entry into the rich sealing grounds of the South Shetlands in 1819 as he obtained it from a descendant of the hero of that occasion, Nathaniel B. Palmer. Certain is it that five American vessels, among them one commanded by Palmer, were in "Yankee Harbor," Deception Island, in the summer of 1820–1821, where they were encountered by Bellingshausen.

In January, 1829, Deception was visited by the *Chanticleer*, Captain Henry Foster, who used the island as a pendulum station in his voyage to collect data for determination of the figure of the earth. Graphic descriptions of its volcanic features were written by the ship's doctor, W. H. B. Webster, and Lieutenant Kendall. The latter made a survey of the island and left there a minimum thermometer. Fogs are so frequent, he says, that for the first ten days they saw neither sun nor

star. Another brief account is by Lieutenant Robert E. Johnson, of the Wilkes Expedition, who visited Deception in 1839. He failed to find the thermometer left by the *Chanticleer*, but it was recovered three years later (minimum temperature of -5° F.) by the sealer William H. Smiley. Smiley wrote that "the whole side of Deception Island appeared as if on fire" and expressed his opinion that the island was undergoing many changes.

In January, 1905, the Argentine vessel *Uruguay* put into the harbor of Deception Island after relieving the meteorological observers on the South Orkneys

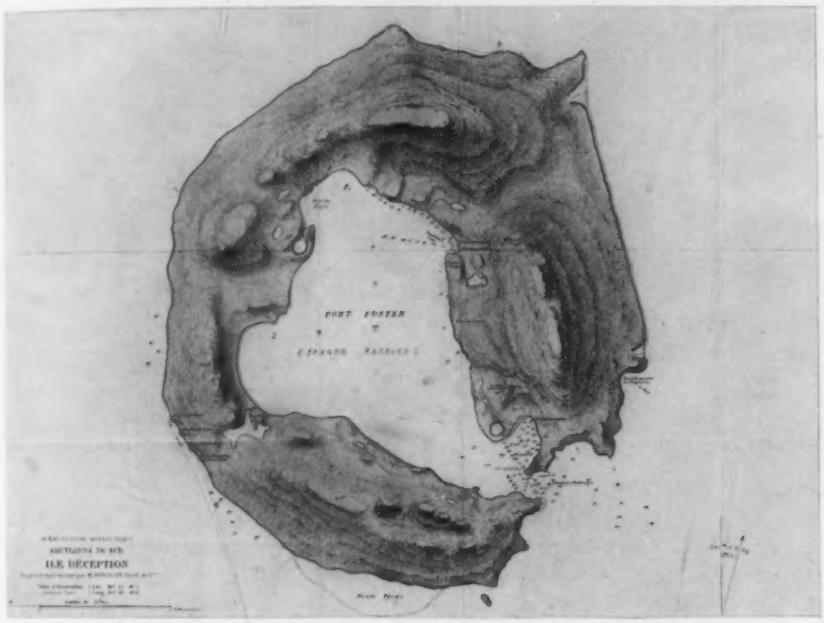


FIG. 38—Reproduction on a scale of approximately 1:200,000 of the French Hydrographic Chart No. 5449 (edition of 1912), from the survey executed by the second Charcot Expedition, 1908–1910. Our runway on the western side of the whaling anchorage has been added.

and noted various changes in its configuration, particularly in Pendulum Cove where the former narrow inlet, "shaped like a comma," was almost entirely filled with ice and ashes. A map showing the change accompanies R. C. Mossman's short account of the voyage (*Scottish Geogr. Mag.*, Vol. 21, 1905, pp. 323–328). The following season marks the entry of modern Norwegian whaling into the South Shetlands waters (see the article by Gunnar Isachsen in this number of the *Geographical Review*). Deception Island, which provides the only site suitable for a shore factory, has thereafter been regularly occupied during the summer months.

Charcot's second Antarctic Expedition spent several weeks on Deception in the summer 1909–1910 (see his narrative "Le Pourquoi-Pas? dans l'Antarctique, 1908–1910," Paris, 1910). The geologist of the expedition has given a brief description of the island, and its rocks have been analyzed. It is entirely composed of fragmental ejecta and lava. An enormous lava dike in the vicinity of Whaler's Cove suggests an ancient volcanic neck, but it is difficult to determine the center of eruption. There are abundant fumaroles with a temperature of 90° C. Only a single glacier, on Mt. Pond, the highest point, is worthy of the name; here layers of ice alternate with layers of ash (compare Figs. 12 and 13). Erosion is intense: torrents sweep down the loose material, and the wind plays an even more important rôle; and the contours of

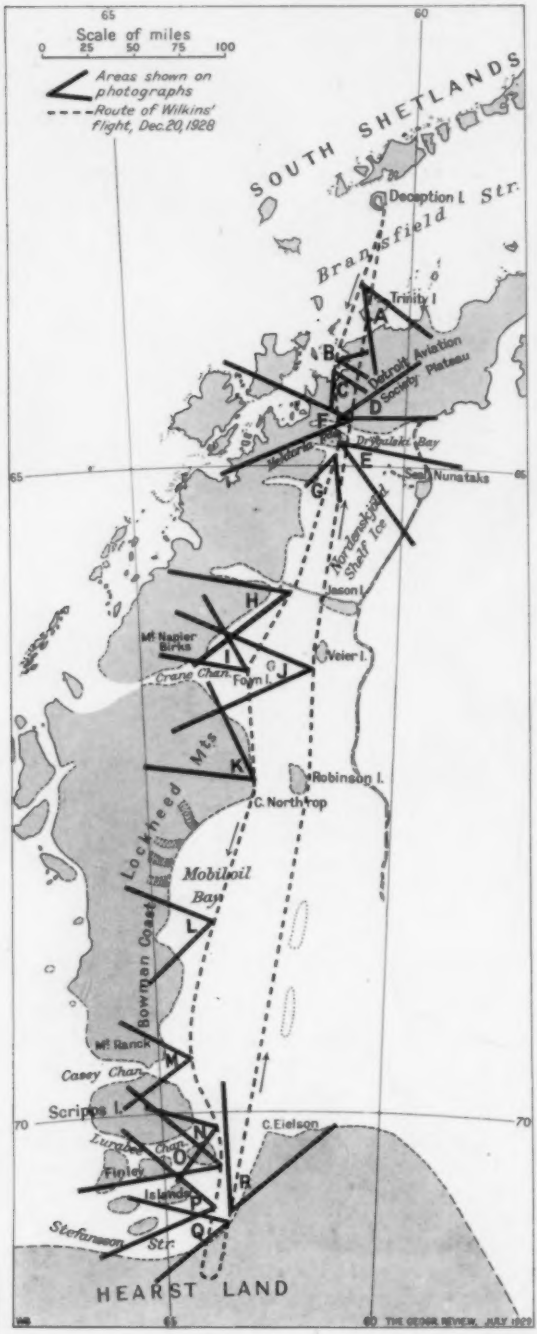
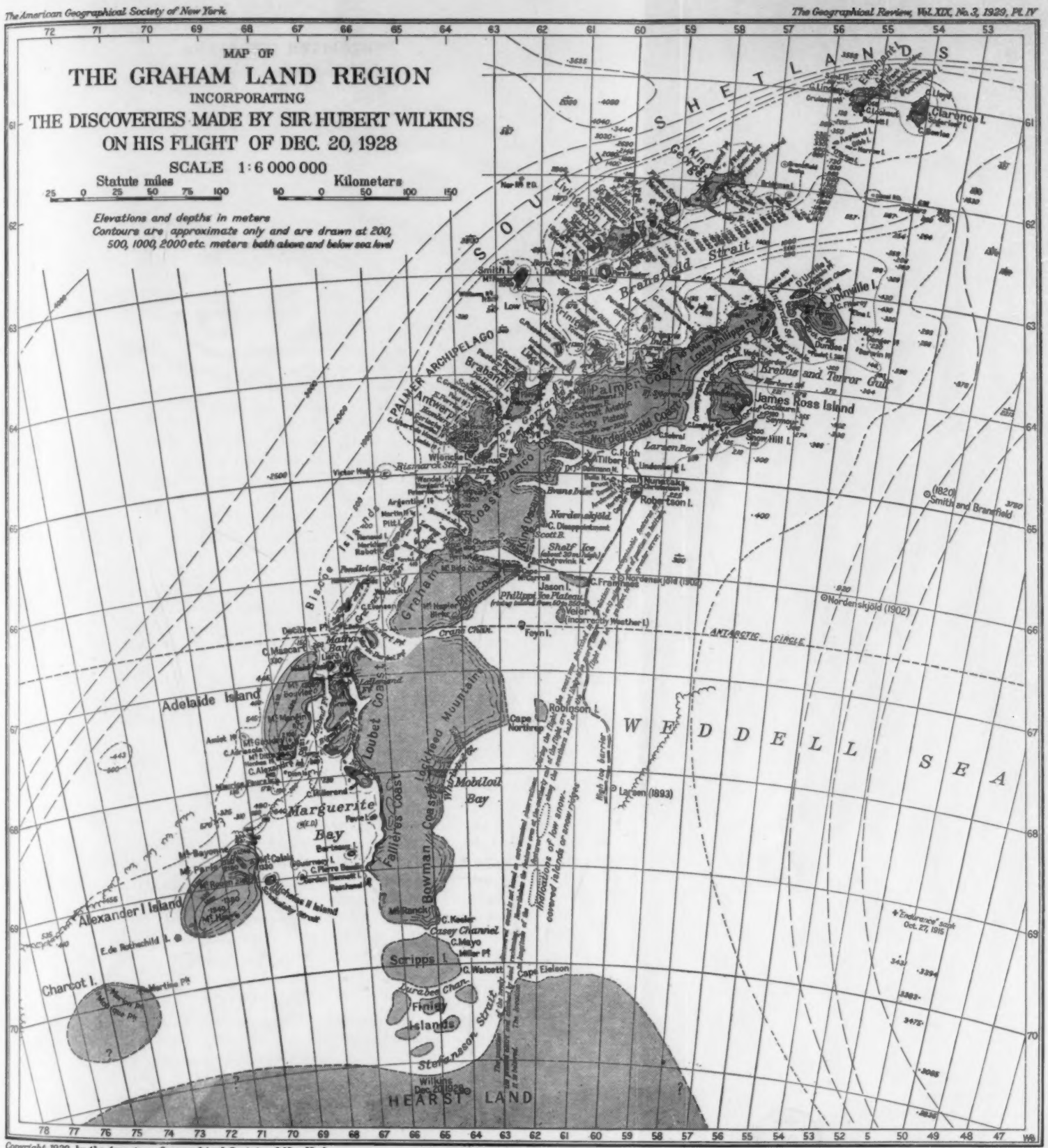


FIG. 39—Map showing location of photographs (by letter) and route of the flight of Dec. 20. A corresponds with Fig. 18; B, with Fig. 10; C, with Fig. 11; D to R, with Figs. 19 to 34. Scale approximately 1 : 6,400,000.

the interior bay are incessantly being modified.

Of particular interest are the meteorological observations by Jules Rouch. Hourly observations were taken on Deception from November 28, 1909, to December 22, 1909, and again from December 31, 1909, to January 5, 1910. The mean of temperature readings for the former period was 0.7° C. (33° F.), for the latter period 2.9° C. (37° F.). Rouch notes that during the interval between the two sets of observations thawing had progressed very rapidly: on the return of the *Pourquoi-Pas?* after the week's absence, "the slopes of Pendulum Cove which we had left snow-covered were almost completely uncovered." Rain was recorded on several occasions, and for only one whole day was mean cloudiness less than 5. During the last week of December and for the period January 6 to March 7 general meteorological observations were made by a doctor at the whaling station. Out of 276 observations (four a day) 28 were recorded as clear; 21 partly cloudy; 155 cloudy; 72 rain or snow. Elsewhere it is noted that the season 1909–1910 was unusually warm in western Antarctica. Comparing the years 1905 and 1909, Dr. Mossman (Meteorology in the Weddell Quadrant During 1909, *Scottish Geogr. Mag.*, Vol. 26, 1910, pp. 407–417) points out that mean temperatures at the South Orkneys and the west coast of Graham Land were much higher in the latter year.



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Acknowledgment and Equipment

I was able to organize the Wilkins-Hearst Antarctic Expedition with the support and sponsorship of the American Geographical Society, through the good offices of the Detroit Aviation Society, the financial aid of Australian and English friends, a gift of $10,000 from the Vacuum Oil Company of Australasia, the sale of news rights to Mr. William Randolph Hearst's Universal News Service, and the promise from the N. Bugge Hektor Whaling Company of Tönsberg, Norway, to carry our machines and crew to Deception Island. Our equipment consisted of the Lockheed Vega monoplane we had used on our Arctic flight and a duplicate new Lockheed plane and accessories supplied by the Lockheed Aircraft Company.

We provided pontoon, ski, and wheeled landing gear for the planes and adequate spare parts for the Wright Whirlwind engines. The Vacuum Oil Company provided adequate supplies of Mobiloil B. and Plume gasoline. Mr. T. R. Conway of Portland, Ore., gave some Alpine climbing gear, Mr. Henry Hughes of London presented me with special compasses and drift indicators for navigation. The Worumba Company of New York gave us some splendid outfits made to our design in suitable camel's-hair cloth. Mr. William Horlick presented us with all the malted milk we required. The Freia Chocolate Company of Norway gave us much excellent chocolate, and the remainder of our supplies and equipment was purchased at a discount from Abercrombie and Fitch and from Anthony Fiala, New York. The American Geographical Society, in addition to a contribution toward the cost of the expedition, provided charts and curves and tables for aiding and simplifying navigation.

The Munson Line generously gave us free freight and half fares for the members of the expedition from New York to Montevideo. At the request of the British Minister, the Hon. R. Scott, and Mr. Parry, his first secretary, the Uruguayan Government gave us many facilities and much assistance, placing a guard over our machines during a temporary delay and giving us the facilities of the port. The Port Captain, Captain Taylor, rendered us much assistance. Dr. Bazano, of the Meteorological Service, gave us photographic copies of charts and much information. With the sanction of the Director of the Argentine Meteorological Service, Mr. R. C. Mossman compiled a comprehensive meteorological summary for our benefit. The help of every one of the companies, countries, societies, and individuals mentioned cannot be too highly commended. There are others also, far too many to mention individually, who have helped in countless ways; and it would please me greatly if they would realize my sincere gratitude for their kind assistance.

I must draw attention to the splendid attitude shown by the N. Bugge Hektor Whaling Company and its employees throughout this season. They were always willing to help, in fact, more willing to help than I was to allow them to interfere with their regular duties. In particular, I must mention Captain Marinius Hansen, Secretary Sverre Neilsen, Dr. Henriksen, and First Mate Thorbjornsen.

I also wish to mention the efficient service of Victor Olsen, our wireless operator, and the splendid coöperation we received from Messrs. Roebuck and Martin, of the *San Francisco Examiner's* short-wave radio staff. It has been a pleasure to work with such willing and efficient people. The help received, of which mention is made above, together with the ready and expert service from Eielson, Crosson, and Porter, each of whom has promised to return to the field next season, has made this year's expedition one outstanding for its absence of friction.

Note on the Map

Plate IV (facing p. 374) reproduces on a reduced scale a portion of the revised American Quadrant sheet of the American Geographical Society's Map of the Antarctic, 1:4,000,000. It incorporates my interpretation of the west coast of Wed-

dell Sea as seen from the air. The flight was made for reconnoitering purposes only. The outline of the coast was sketched in relation to recognizable features on the printed chart and checked by dead reckoning. It cannot be considered complete. Only one set of altitudes was taken at the beginning of the flight when immediately west of Trinity Island, shown on the chart at 63° 45′ S. and 60° 45′ W. The result has been worked out at the American Geographical Society. The altitude used for plotting the resulting position line was the mean of five observations of average precision; and so it is unlikely that the error in the observed altitude exceeds 10′ of arc. In addition the sun's apparent time was accurately known. Therefore it may be assumed that position at the time of the set of observations is somewhere within a band extending ten miles on either side of the position line.

Our set of altitudes, it is believed, was the first astronomical observation in the vicinity of Trinity Island controlled by an accurate knowledge of standard time, previous expeditions not having the advantage of radio time signals; but the plotted position line cuts latitude 63° 45′ S. at approximately 56° W. instead of longitude 60° 45′ W. However, no final reliance can be placed on this one position line, and it remains for future observers to determine whether or not the whole of the region about northern Graham Land is too much to the westward.[6]

Although it was not possible to make any astronomical observations at the southerly end of the flight, it is believed that the features there plotted are not likely to be more than five or ten miles out of position in latitude in relation to recognizable features on the American Geographical Society's map. The location in longitude of the features along the southern half of the flight may be subject to greater error.

The new place names upon Plate IV are: Detroit Aviation Society Plateau; Hektoria Fiords (after S. S. *Hektoria*); Evans Inlet (after E. S. Evans of Detroit); Cape Fritsche (after Carl B. Fritsche of Detroit); Cape McCarroll (after H. G. McCarroll of Detroit); Mt. Napier Birks (after Mr. Napier Birks of Adelaide, Australia); Crane Channel (after C. K. Crane of Los Angeles); Cape Northrop (after Jack Northrop, the designer of our Lockheed plane); Lockheed Mountains (after the Lockheed Aircraft Company); Whirlwind Glaciers (after the Wright Whirlwind engines designed by Colonel Laurence); Mobiloil Bay (after the Vacuum Oil Company of Australasia); Bowman Coast (after Dr. Isaiah Bowman, Director of the American Geographical Society); Mt. Ranck (after T. V. Ranck of the Hearst general management); Robinson Island (after W. S. Robinson of London and Australia); Casey Channel (after Major Richard Gardiner Casey of Melbourne, Australia); Cape Keeler (after Fred E. Keeler of the Lockheed Company); Cape Mayo (after William B. Mayo of the Ford Motor Company); Scripps Island (after William Scripps of Detroit); Miller Point (after George E. Miller of Detroit); Cape Walcott (after Frederic C. Walcott of the Council of the American Geographical Society); Lurabee Channel (after Lurabee Shreck of San Francisco); Finley Islands (after Dr. John H. Finley, President of the American Geographical Society); Stefansson Strait (after Vilhjalmur Stefansson); Cape Eielson (after my friend and companion Carl B. Eielson), Hearst Land (after William Randolph Hearst).

[6] It may be noted that the 1925–1927 *Discovery* expedition confirmed the plotted position of Deception Island (according to Lieut. Commander Chaplin, *Geogr. Journ.*, Vol. 72, 1928, p. 233), the latest published determination of which is that made on the second Charcot Expedition, 1908–1910, of a point near the harbor entrance in 62° 55′ N. and 60° 38′ W. of Greenwich (French Hydrographic Chart No. 5449, edition of 1912). Wilkins' compass course from Deception Island to Charlotte Bay (on the west coast of Graham Land in latitude 64° 20′) past the western side of Trinity Island is given as 190°, or about S. 25° W. true, in his log book in the possession of the American Geographical Society, and the distance to Trinity Island as 48 miles. If the charted position of Deception Island is correct, then this bearing and distance confirm the position of Trinity Island as shown on the latest charts (e. g. British Admiralty No. 3205, revised to 1928).—Edit. Note.

THE SIGNIFICANCE OF SIR HUBERT WILKINS' ANTARCTIC FLIGHTS

Hugh Robert Mill

AS the pioneer of exploration by aircraft in the Antarctic regions Sir Hubert Wilkins has demonstrated the practical value of his methods in a field of peculiar difficulty. He chose that portion of the Antarctic regions where land was first discovered and in which ships have traded and explored for more than a century, yet in four and a half hours of flying he obtained such a view of the geography of an area of more than 100,000 square miles as could not have been constructed from all the records of all the explorers that went before him.

Three physical conditions have combined to retard and perplex Antarctic exploration, though in recent years some of them have lost much of their ancient power. First, there is the remoteness of the region from established trade routes and ports offering facilities for equipment. Secondly, the climate has frequent interchange of gales and fogs, and there is but a small part of the year when the long summer daylight allows of reasonably safe navigation in uncharted waters. Bad visibility and mirage often spoil the angular measurements used for determining heights and distances on the surface and astronomical observations for position. All the blurred impressions so produced have naturally built up a vague and shifting picture in which it is always difficult and often impossible to reconcile the reports of different voyagers. The third difficulty is that presented by sea ice and icebergs, whose distribution and periods vary in the most baffling manner. Thus it is not surprising that most of the land in West Antarctica has been sighted in fitful glimpses as it loomed out of the mist, and one landfall may never have been seen in its true relation to another situated not far from it.

Geographers have too often fallen into the easy error of their sixteenth-century predecessors and sketched in hypothetical coasts without a clear indication of how much has been seen and how much assumed. It follows that each successive explorer has more than enough to do in correcting the defective charts of his predecessors before plotting his own discoveries to puzzle whoever has to follow in his track, and so it is not irrelevant to look at the order in which the outlines of West Antarctica have been felt out before the coming of the Lockheed planes.

A Century of Discovery

When Captain Cook completed his second voyage of circumnavigation he passed the region of West Antarctica in too low a latitude to make any discovery of land there; but by lighting on the Isle of Georgia (now called South Georgia) he made known to the world the wealth of the region in seals, and an active fur trade sprang up before the end of the eighteenth century—the sealers hailing from New England as well as from British ports. They may possibly have visited the nearer islands of West Antarctica before the discovery of the South Shetlands by William Smith in 1819 and the first survey of the neighborhood by Mr. Bransfield of the Royal Navy in the following year when the coast south of the South Shetlands was named Trinity Land. Bellingshausen with the Russian South Polar expedition approached the South Shetlands from the southwestward in 1821 after finding the first land known south of the Antarctic Circle, Peter I Island and Alexander I Land, both in nearly 69° S. He met the American sealers, notably Nathaniel Palmer, quite at home amongst the islands and on the coast to the southwest which appeared to be a mainland and was named Palmer Land by Powell probably in ignorance of Bransfield's work.

In 1823 Weddell, taking advantage of a uniquely ice-free year, reached 74° S. on the meridian of 34° W. Morrell, the most entertaining if not the most trustworthy of the American sealers, spoke of navigating the same sea in the same year and of having killed seals on the coast of a land named by Johnson, a senior in the American sealing trade, New South Greenland, in longitude about 50° W. The crater bay of Deception Island or one of its many coves was already known as Yankee Harbor, and there are few more fascinating records of exploration than that compiled from the logs of the Stonington sealing fleet by Mr. E. S. Balch. *H. M. S. Chanticleer* in 1829, in the course of the first geodetic observations in the subantarctic area, fixed the position of Deception Island and took possession for the British Crown of the extensive land to the south then known as Trinity Land or Palmer Land and renamed Clarence Land by Captain Foster. In 1832 Biscoe with two of Enderby's sealing vessels, following nearly on Bellingshausen's track, discovered and named Graham Land on the Antarctic Circle and a chain of islands running parallel to its coast, Adelaide Island just south of the circle and the Biscoe Islands continuing to the northward. It appeared possible that Graham Land was the west coast of an extensive land mass that stretched eastward to New South Greenland and northward to Trinity, Palmer, or Clarence Land. In 1838 Dumont d'Urville with the French expedition failed to penetrate Weddell Sea but discovered Joinville Island and Louis Philippe Land from the eastward at the northern extremity of what ultimately came to be called the

Graham Land peninsula. Wilkes in the United States exploring expedition, in ignorance of Dumont d'Urville's prior discovery, sighted the same land in 1839. These discoveries were confirmed by Ross in the *Erebus* and *Terror* while returning from his great Antarctic voyage in 1843, and he also penetrated to some distance into Weddell Sea.

In 1874 the first steam vessel to enter these waters, the German sealer *Grönland* under Dallmann, pushed her way to nearly 65° S. on the west side of Graham Land and reported that such charts as existed were quite untrustworthy. Next, in 1892, came four Dundee whalers seeking to reëstablish the whaling enterprise of their port, but they found their gear, which was adapted for killing the Greenland right whale, useless against the great blue whales off the coast of Louis Philippe Land.[1] C. A. Larsen, in a Norwegian whaler, was sent out by a Hamburg firm in the same year to the same region, and in 1893 he returned with two other Norwegian vessels. Then in the *Jason* he penetrated Weddell Sea south of Joinville Island and traced the coast line of a mountainous land, which he named after King Oscar II, as far south as 68° S. If this land was the New South Greenland of the American sealers, as seems probable, it was situated 10° farther west than originally reported. In any case it was probably the east coast of Trinity Land and Graham Land. The mountainous country rose from a broad shelf or barrier of ice which prevented Larsen from landing on it, but he fixed the position of several mountains and islands. At the same time the *Hertha* under Evensen penetrated Bellingshausen Sea and reached 69° S., passing the Biscoe Islands and sighting Alexander I Land.

In 1897 Gerlache in the *Belgica*, the first exploring vessel to commence the modern systematic exploration of Antarctica, made a remarkably accurate running survey of the complicated islands and channels along the Graham Land coast, which had never previously been charted. The work he did was corrected and extended by Dr. Jean Charcot in the *Français* in 1903–1905 and in the *Pourquoi Pas?* in 1908–1910, discovering new land to the south and west of Alexander I Land. Meanwhile the expedition of Otto Nordenskjöld on the east coast in 1901–1903 filled in some details in the northern sections and made some corrections of the map nearly as far as 66° S., while Dr. Bruce, in the *Scotia*, for the first time outdistanced Weddell and discovered Coats Land in the south of Weddell Sea. Filchner in the *Deutschland* in 1912 and Shackleton in the *Endurance* in 1915–1916 carried the southern shore of Weddell Sea to 78° S. and, by their involuntary drifts northward on parallel courses about 200 miles apart, practically negatived Bruce's theory that Morrell Land, or

[1] See the following article "Modern Norwegian Whaling in the Antarctic," by Gunnar Isachsen. —Edit. Note.

New South Greenland, was an extensive island or archipelago in the longitude alleged for it.

The enormous development of modern whaling led to a wider and more precise knowledge of the western side of Graham Land, some of the whalers of the Scottish firm of Salvesen reporting the existence of a great strait or channel leading eastward in about 70° S.[2] Surveying vessels of the Falkland Islands Dependencies have also been pursuing systematic coast surveys, and the map was in a favorable state of development. Then Sir Hubert Wilkins arrived to take a birds'-eye view of the situation.

Entry of the Airplane

Up to this time the breadth of Graham Land could only be guessed by reference to the few satisfactory longitudes observed on or near the two coasts, its eastern side being unvisited south of 68° S. and no expedition having ever penetrated to the interior or attempted to cross the backbone of high land. It was generally held that the peninsula was an offshoot from the great Antarctic plateau supposed to extend from the pole to the neighborhood of the Antarctic Circle or at least to 78° S. all round, though some theorists suggested a possible water connection between Ross Sea and Weddell Sea dividing the Antarctic into two separate land masses, Graham Land being the northern tip of one and Victoria Land that of the other.

It would be too much to claim that the two flights made from Deception Island have solved any of the great Antarctic problems which have been puzzling explorers and students for generations past; but they have done more to suggest possible solutions and to point the way to future investigations than any other two-days' work since exploration began. The difficulty as to a suitable starting place was inevitable when the base had to be on Deception Island. If it had been possible to land the planes and stores on a large level stretch of snow well within the Antarctic circle and to pick them up again at the end of the season, the amount of work done might have been substantially greater; but to ensure this result the expedition must have had a big ship of its own and a plan of action similar to that of Commander Byrd's expedition.

I feel strongly that the future of aircraft in polar exploration depends on the invention of an effective airplane which can rise vertically or at a very steep angle and descend similarly on a restricted space, thus making landing practicable at will even in rough country.

[2] In the March, 1929, number of the *Geographical Journal* Mr. J. M. Wordie discusses this report, which is contained in a letter by Mr. H. K. Salvesen appearing in the *London Times*, Jan. 5, 1929, p. 8. It is based on independent observations of two whale catchers in February, 1924. In both cases the opinion was "that the Fallières Coast turned sharply in an easterly direction and that there was here either a channel to the Weddell Sea or at least a very extensive bay or sea."

Until such machines have been perfected serious exploration is confined to airplanes dependent alternatively on wheels, skids, or floats according as a smooth runway over land, snow, or water is available. Whatever possibilities there may be for exploration by lighter-than-air craft in the Arctic regions, there can be none for many a long day in the Antarctic on account of the immense distances which must be traversed to and from any possible base and the terrific force of the Antarctic winds.

I confess that my chief fear for Sir Hubert Wilkins when he started on his expedition was that his enthusiasm might outrun his discretion and that he might attempt a long flight trusting to luck for a safe landing at the far end. I consider it one of his greatest triumphs that he made sure of his return with the modest gains of a few well conducted flights as a guarantee of greater results later when the fruits of experience have matured.

Problems of the Graham Land Region

No line towards the South Pole in the neighborhood of the Antarctic Circle can present more interest to the aerial observer than that along the axis of Graham Land. Here the two coasts had been felt out separately in conditions of extraordinary difficulty, but they had never been connected by sea or by land; so that it was impossible to say what the breadth of the peninsula really was from point to point. Similarly no opportunity had ever occurred before of testing the existence of channels dividing Graham Land into a series of islands, although on more than one occasion western inlets had been observed which sailors had recognized as leading to possible straits. Wilkins was able in his first flight along the eastern side of Graham Land on December 20, 1928, to see both coast lines at the same time, in the north at least, and to look down upon the quite unknown central plateau occupying the northern section, thus uniting the work of Larsen and Nordenskjöld on the east with that of Biscoe and Gerlache on the west. He was able also to state that Graham Land consists of a northern and a southern section and that the southern portion is divided by a wide and well marked strait containing several large islands from the Antarctic Continent or at any rate from some extensive land on the south. He was able to identify most of the islands off either coast, so far as they had been authoritatively mapped, and to descry other islands which had never been seen from the surface. All this was possible in the one day because of the great speed and the great height at which he could fly and because of his experience in the Arctic of the appearance of different ice formations from the surface and from the air.

There still remains in my mind some uncertainty—which, indeed,

Sir Hubert Wilkins seems to share—as to whether it is possible to distinguish between actual sea channels blocked with continuous ice and flat-bottomed valleys covered with compacted snow and not depressed below sea level. The point is interesting, although of course it is not the depth of the channels but the geological structure of the land which must be ascertained in order that light may be thrown on such problems as the possible extension of the Andean chain through Graham Land towards the Antarctic Continent. In so heavily glaciated a region it must always remain difficult, if not impossible, to map the border line between land and sea, unless photographs taken from a great height can discriminate between different types of ice formation.

Accepting the track of the airplane as being laid down with the closest possible approximation to accuracy and recognizing the exceptional fitness of Sir Hubert Wilkins to explore and to describe what he has seen, I desire, though with much diffidence, to suggest some points on which he may shed more light. I am not qualified, nor is there room in this article, to discuss fully the changes made in the map and the degree of confirmation afforded by the intensely interesting photographs taken on the flight; and I am most anxious that nothing I may say should appear to cast any shadow on the swift and splendid achievements of the expedition. But a lifelong student of Antarctic exploration necessarily looks on the records of an expedition with a critical eye and requires clear proof before endorsing any claims which, if accepted, might discredit the work of earlier discoverers. An hour's conversation would probably dispose of many of my comments; but, that being impossible, I shall deal in order, from south to north, with the matters suggested by the map.

South of 68° S. Wilkins was over entirely new ground, and his discovery of Stefansson Strait and the islands and channels that separate it from South Graham Land and from the rising land to the south covers a stretch of 200 miles seen by no one before him. Hearst Land may or may not be part of the continent, and it would be preferable to limit it on the map to the range of distinct vision. It would be helpful also to know how far to the westward the great strait was actually seen to extend. For instance, was Alexander I Land sighted?[3] The photographs amply prove the existence of a wide strait with many islands. If the return flight had been made along the western side of Graham Land the connection of Wilkins' discoveries with those of Charcot would have been most useful.

The actual line of the return, well to the eastward of the outward course, enabled a double check to be made on Larsen's discoveries

[3] Since writing this I have had the pleasure of meeting Sir Hubert Wilkins, who tells me that Alexander I Land was not seen as in the southern part of his flight he descended to 2000 feet in order to observe the surface appearances.

of 1893; and here a description of the land seen in flying north in the altered light would have assisted in the identifications. The descriptions of the land on the outward flight might also have been fuller in view of the interest of a comparison with Larsen's log.[4]

Comparison with Larsen's Discoveries

It is obvious that Wilkins' "indications of low snow-covered islands or snow ridges" and his Robinson Island in line to the north of them are a continuation southward of the features which Larsen from the sea close to them took to be the coast of the mainland, "which rose quite evenly from the sea westward to considerable heights." Could Wilkins from his great height in the air be sure that what he took for a flat expanse of barrier ice, 70 miles wide, between those islands and the coast near Mobiloil Bay, was not in fact very low flat land? The equivalent of Wilkins' Robinson Island appears on Larsen's map as a promontory where his coast dips into a large bay westward and then northward to Foyn Land. Wilkins' conception of the relation of Foyn Land, Jason Land, and Veier ("Weather") Island[5] was based on Charcot's general map on which Foyn Land, instead of being represented as on Larsen's map as part of the mainland coast, is implied to be an island. Hence the identification of the island seen opposite Crane Channel (Fig. 26, p. 365) with Foyn Land. But is it not possible that Wilkins' Foyn Island is a new discovery that escaped Larsen because, viewed from his vessel, it merged into the background of the mainland coast? In that case Wilkins' embayment at the head of which lies Crane Channel might well correspond with Larsen's westward reëntrant, and Larsen's high coast to the south with the coast formed by the Lockheed Mountains. Similarly the "very high peak" which Larsen saw nearly W.S.W. of Framnaes is possibly Mt. Napier Birks.

The Question of Through Channels

I cannot free my mind from doubt as to the number of islands into which Graham Land north of Stefansson Strait may be divided. Possibly Crane Channel may not go clear through, for Wilkins does not say that he saw it throughout its whole length; but until disproved by later exploration I am inclined to accept it. I may, however, note that in the very fine photograph of Mt. Napier Birks from the south-

[4] See Johannes Petersen: Die Reisen des "Jason" und der "Hertha" in das Antarktische Meer 1893/94 und die wissenschaftlichen Ergebnisse dieser Reisen, *Mitt. Geogr. Gesell. in Hamburg*, 1891–92, pp. 244–305. The Norwegian original, "Nogle optegnelser af sæl-og hvalfanger 'Jason' reise i Sydishavet 1893 og 94," appears in *Det Norske Geogr. Selskabs Årbog*, Vol. 5, 1893–1894, pp. 114–131.

[5] A new map of Larsen's discoveries in 1893 is being prepared in Norway. In conjunction with it attention is called to correction of the name "Weather Island." It should be "Veier Island," named after the home of the man who first sighted the island. Apparently "Veier" was confused with "veir" (weather) in the first German and English accounts of Larsen's discoveries, and the error has been perpetuated.

east, showing the mountains rising from Crane Channel, the entire foreground is occupied by a heavily crevassed glacier which implies a considerable gradient in the stream of ice and suggests a valley rather than a flat-floored depression. On the other hand the idea put forward by several explorers that North Graham Land is divided by channels leading from sea to sea is rendered improbable by the aerial photographs, though these do not altogether exclude the possibility that the land is deeply cleft between the Richthofen Valley on the east and Dallmann's Bismarck Strait on the west and between Evans Inlet and Flanders Bay.

Two very interesting discussions of Wilkins' preliminary reports in the press have already been made by the men who by general knowledge of the polar regions and special acquaintance with Weddell Sea are the best qualified to deal with the subject, Mr. J. M. Wordie, of the *Endurance* expedition in the *Geographical Journal* for March, 1929, and Dr. R. N. Rudmose Brown of the *Scotia* expedition in the *Scottish Geographical Magazine* for March 15, 1929. Both take up the question of the possibility of Stefansson Strait ever being ice-free and navigable, pointing to the rotary circulation of Weddell Sea as evidence that the southwestern side is normally closed; but they concur in suggesting that some of the anomalies of the ice conditions of that sea might be explained if on exceptional occasions Stefansson Strait were open and allowed the ice from the southern part of Weddell Sea to escape before the prevailing easterly winds into Bellingshausen Sea. Mr. Wordie asks whether the extraordinary feat of Larsen in reaching 68° S. in 1893 might not have been due to such an occurrence in that year, and Dr. Rudmose Brown asks whether the ice-free year 1823, when Weddell reached his high latitude, may not have been due to the same cause.

The demonstration of the high and very flat plateau occupying the central part of North Graham Land ranks in my opinion as a discovery only a little less important than that of Stefansson Strait, and each introduces a series of new problems for geographers to investigate. That a high ice plateau should occupy the center of the great Antarctic Continent or even the huge island of Greenland can be explained from climatic consideration; but how such a condition can arise on a comparatively small island on the temperate side of the polar circle is more difficult to explain. I am not sure that the greatest value of the work done on that eventful day December 20, 1928, is the revelation of a book of questions calling for new research.

I am not inclined to rely on the astronomical observations made from the air, which appear to place Trinity Island four degrees out of its charted position in longitude. It seems impossible that such an error in position in a large island was not detected by the numerous vessels now frequenting Deception Island and the waters to the south.

Future Work

The map compiled by the American Geographical Society (Pl. IV, facing p. 374) seems to have been drawn with skill and care, and it is a new thing in cartography that many hundred miles of coast have been redrawn and a dozen new islands inserted, however sketchily, as the result of one sustained rush through the air at 120 miles an hour. It will take years of laborious work on land and sea or months of systematic aerial survey to test and verify or correct the interesting outline now presented, but I view it as a magnificent pioneer performance redounding to the credit alike of the flyers and of the cartographers who interpreted them. It is good news to hear that Sir Hubert Wilkins, in the coming season, proposes to resume his exploration of the Antarctic by air. If, as he hopes, it is possible to establish a base on Hearst Land by aerial transport, I hope that he will take the opportunity in passing to and fro to make diagonal crossings of Graham Land to link known features on west and east. Will he now also reconsider his plan of flying westward along the coast to King Edward Land and Ross Sea? He may find that the first big piece of work to be done is to connect Hearst Land with Coats Land by a flight towards Herzog Ernst Bay in Weddell Sea, which might go far towards settling the question whether the Antarctic Continent is one continuous unit or two lofty land masses separated by the sea. Of course I recognize that an explorer works best when carrying out his own ideas, and no one will blame Sir Hubert if he prefers to leave the solution of the greatest problem of the Antarctic to a later explorer and confines himself to the very useful endeavor to fix the ocean coast of West Antarctica.

The success of his efforts in 1928 satisfies me that henceforth the employment of small scouting seaplanes with a radius of a hundred miles or so which could rise from the sea in the lee of an exploring ship will be an essential part of every expedition.

Nomenclature of Discoveries

The nomenclature of new discoveries is a theme so tempting and so open to controversy that I feel, like Shakespeare's "poor cat i' the adage," greatly desirous of expressing my views but salutarily cautious as to entering on dangerous ground. I will say that it is right and reasonable for an explorer to wish to enshrine the names of his patrons and friends in prominent places on his map. But I should also like to point out that not all names bestowed by explorers stand the test of time. Weddell's loyalty prompted him to christen the scene of his great feat "George IV Sea"; posterity has decreed that it should be known forever as Weddell Sea. Tasman honored his patron by naming an island Van Diemen's Land; but everyone now calls it

Tasmania. It seems not improbable that the geographers of the future will prefer to call the broad strait south of Graham Land by the name of Wilkins and perhaps the narrow channel farther north after his pilot Eielson.

When names are short, simple, and appropriate there is little reason to doubt that those put forward by the explorer and his sponsors will be adopted by any government exercising territorial jurisdiction. Thus Captain Cook's humorous naming of the first land sighted on the east coast of New Zealand "Young Nick's Head" after the ship's boy, Nicholas Young, who was the first to see it remains unquestioned on the map while many others apparently more worthy of retention have failed to keep their place. The names of men who have done notable work in any region are more likely to be retained in perpetuity than those of others, perhaps much more distinguished in their own sphere, which are given only as a compliment or from a sense of duty. In 1905 I suggested that the name Graham Land might well be restricted to that portion of the land south of the Antarctic Circle.[6] This, it now appears, is Wilkins' South Graham Land. Might I now suggest the revival of Trinity Land, as given by Bransfield in 1820 and used by Weddell in 1823, for "North Graham Land," and the retention of Louis Philippe Peninsula for its northern extremity and the calling of its east coast after Larsen? West Antarctica has become familiar, if not yet official, as the general designation of the whole area.

I have thrown a stone into what may well be the funnel of a geyser and hasten to escape from dangerous ground before I find myself in hot water.

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[6] The Siege of the South Pole, 1905, p. 162.

MODERN NORWEGIAN WHALING IN THE ANTARCTIC

Gunnar Isachsen

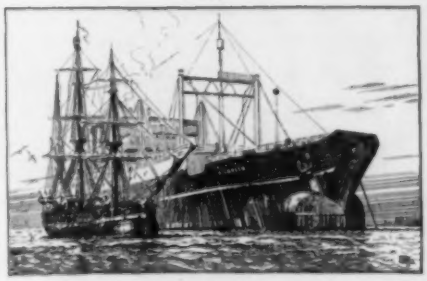

FIG. 1—The *C. A. Larsen*, 13,246 tons, of Sandefjord and the old whaler *Harpooner* of Hull (*c.* 1780), 200 tons. (From a drawing by H. H. Rodmell in the Museum of Fisheries and Shipping, Hull.)

ALL whalers and many scientific folk know by name at least the Norwegian whaling towns Tönsberg, Sandefjord, and Larvik. Among them Sandefjord now holds in Norwegian whaling the place that New Bedford once held in the American industry. Most of the whaling of today is done in Antarctic waters, and the present concern in Antarctic exploration has drawn attention to this industry that offers so much of interest to scientist as well as fisherman.

But, while whaling captains and gunners may talk among themselves of their experiences, they usually are little inclined to write about them. There is no more brotherhood in whaling than in gambling! Like the early sealers in these same waters they keep to themselves discoveries which have to be made over again by others before they become part of our common knowledge. While many corrections in the charts are made from reports by whalers, the most important information they still carry in their heads. True, there have been some notable exceptions, which we shall mention later; and under present arrangements of the authorities concerned, Norwegian and British, we may hope that valuable records will be preserved. Nor in estimating our obligations to the whalers must we overlook the debt owed them by scientific expeditions. The expeditions of Charcot, Filchner, Shackleton, Wilkins, and Byrd have all received valuable assistance, while many smaller expeditions have been aided to such a degree that they have been essentially dependent upon what we should regard as an expression of Norwegian hospitality.

EARLY TYPES OF WHALING

The background of modern Norwegian whaling in the Antarctic lies in the dim past. From time immemorial the Norwegians have hunted

FIG. 2

FIG. 3

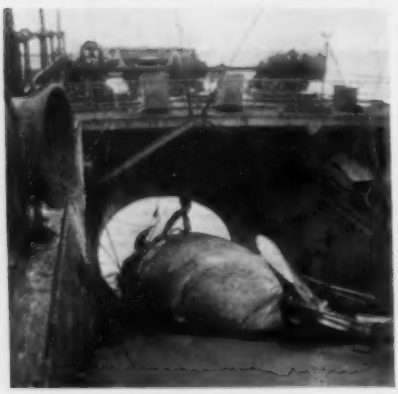

FIG. 4

FIG. 2—A modern whaling gun. (Photograph by Sir Hubert Wilkins; copyright by *New York American* and Universal Service.)

FIG. 3—Flensing a whale at the side of the ship.

FIG. 4—Taking a blue whale on deck of the *C. A. Larsen* by the slip (compare Fig. 9).

seal and whale. The Basques, who had developed a flourishing whaling industry in the twelfth and thirteenth centuries, not improbably learned their trade from the Vikings settled in Normandy and Ireland, with whom they had connections.

The early whaling was shore whaling. As the whale became scarcer it was necessary to seek it farther and farther from land and with larger vessels. At the end of the sixteenth century we find Basque boats hunting whale at Newfoundland, Labrador, and Iceland, and in the beginning of the seventeenth century at Spitsbergen, where they met Dutch, English, German, Danish, and Norwegian whalers. While it was the nordcaper, which took its name after North Cape in Norway, that was hunted in the temperate seas, it was its close relative, the Greenland right whale, or bowhead, that was caught in the Arctic seas. After about thirty years' intensive whaling at Spitsbergen the field of operations moved westward to the ice border in the Greenland Sea, Davis Strait, and Baffin Bay. This whaling lasted on a large scale till the end of the eighteenth century, thereafter declining. As the right whales grew scarce, the whalers had to hunt seals and later the bottlenose as well.

The Scottish whalers discontinued operations before the World War. The last remnants of the once large Dutch and German whaling fleets were a few ships under the Norwegian flag equipped and manned in Norway. The last

Norwegian whaler of this type was the propeller-driven bark *Samson* which now, as the *City of New York*, is Byrd's flagship.

A second type of whaling was begun in the early eighteenth century by the colonists on the New England coast—whaling in the open sea for the sperm whale, a large-toothed whale that occurs in all seas except the Arctic. English and German whalers followed suit. The climax was reached about 1840, when the world fleet counted over 800 whaling vessels, of which almost 600 were American. The trips lasted from one to several years. At the same time the humpback was caught in the shallow coastal waters of Africa, and fur seal and sea elephants in the subantarctic islands. This was the period of the so-called mixed voyages. After 1848 American whalers went all the way to Bering Sea and still farther north to get the bowhead. Marked decline set in about 1860 as competition in other kinds of oil—mineral oil and later also vegetable oil—gradually made whaling less profitable. The hunt of the sperm whale was entirely discontinued during the World War, though there have been a few later attempts to revive it.

The same technique was employed for catching the nordcaper, the right whale, and other related forms occurring farther south (as *Balaena japonica*, *B. australis*, *B. antipodarum*), the sperm whale, and the bottlenose. The whale was approached in a rowboat and made fast with harpoon and line, thereafter being killed with lance or

FIG. 5

FIG. 6

FIG. 7

FIG. 5—Cutting blubber on deck in the Ross Sea, 1927.

FIG. 6—Cutting up the fat tongue. All the whalebone or true whales have a large fat tongue.

FIG. 7—Right whale, Husvik Harbor, South Georgia, 1912.

FIG. 8—Whaling station, Strömness, South Georgia, 1910.

bomb. The ships were sailing vessels—schooners, brigs, and barks of 100 to 400 tons burden.

As the old type whaling grew less profitable, attention was naturally turned to the great multitudes of other whales—the blue whale; the common rorqual, or finback; the sei whale; and the humpback. Attempts were made to catch them with the old technique but without success, as these quick wild creatures when wounded set off at terrific speed, and, unlike the right and sperm whales, they do not float when killed.

A NEW TECHNIQUE AND ITS APPLICATION IN ANTARCTIC WATERS

The problem was solved by the Norwegian seaman and sealer, Svend Foyn (1809–1894), whom Dr. Mill has well described as "a man of the most remarkable perseverance, courage and originality."[1] In 1868, after years of effort and expensive experiment, he invented the grenade harpoon, shot with a line from the whaling steamer, the grenade exploding in the whale with killing effect. An air pump by which the whale carcass could be made to float was also invented.

This technique ushered in the third stage in the history of whaling. It began on the coasts of Östfinnmark and by 1886 counted 19 land stations and 35 whaling steamers. As returns gradually decreased in the nineties, some stations were abandoned, while others were moved westward along the coast and later to Spitsbergen. A few companies took up whaling in Iceland, where the industry reached its height in 1902 with 30 vessels and was discontinued in 1915. Grounds at the Faeroes were taken up in 1894, at the Hebrides and Shetlands in 1903, and off the northwest coast of Ireland in 1907. In the nineties whaling was begun in the east Asiatic seas and at Newfoundland.

In the northern seas as a whole the new whaling reached its climax in 1905, when 24 companies with 63 vessels caught 2671 whales that yielded 83,000 barrels of oil besides by-products. Expenses of the industry, however, were increasing to a point when it could no longer be prosecuted with profit. It was necessary to look for new grounds.

[1] H. R. Mill: The Siege of the South Pole, New York, 1905, pp. 379–380.

FIG. 9—The *C. A. Larsen*, floating factory ship. Note the slip in the bow and compare Figure 4.

There was a virgin field in the southern hemisphere; but it was a question whether it would pay to send hunting expeditions so far.

In the first place the whaling vessels were small craft for the long and arduous voyage: steamboats of iron or steel, of 60 to 90 tons net register, about 80 feet long and 16 feet wide, and capable of making 9 to 9½ knots. But the whalers had no fears on this ground. In the second place they were dependent on land stations for the reduction of blubber and carcass. Little or nothing was known about possible harbors and land stations in the south or of the ice conditions. Here an alternative solution presented itself: substitution for the land station of a floating factory, free to move as conditions required. After several attempts the Framnaes plant at Sandefjord succeeded in converting the steamer *Admiralen* into a floating factory, which was tried out in the Spitsbergen grounds in 1904 and 1905.

The third and most important question was as to the number of whales in the southern seas. James Clark Ross[2] and many before him had reported great numbers of right whales at the ice borders in the Antarctic seas. In 1892 the whaler *Jason*, from Sandefjord, Captain C. A. Larsen, visited the eastern side of Graham Land just where Ross had reported seeing so many right whales. On December 26 she met three of four Scottish whalers, sent out from Dundee, also in search of the right whale. None of the vessels, however, got any. They saw only blue whales and finback which could not be caught with their equipment. Not to return empty-handed, the vessels hunted seal. The Scotsmen made no further attempt. The Norwegians, however, went south again in the fall of 1893, two other similar vessels, the *Castor* and the *Hertha*, accompanying the *Jason;* but only a few right whales were caught.

Ross had also reported abundant whales in Ross Sea. To investigate the possibilities here the "grand old man" of Norwegian whaling, Svend Foyn, now 84 years old, sent H. J. Bull with the whaler *Antarctic* to spend the season 1894–1895 in that area. No right whales were observed; but, on the other hand, there were great numbers

[2] J. C. Ross: A Voyage of Discovery and Research in the Southern and Antarctic Regions During the Years 1839–43, 2 vols., London, 1847.

of blue whale. Bull expressed the opinion that the discrepancy between Ross's statement and his own experience was due to the wholesale capture of the right whale on its migrations in more northerly waters; but current whaling opinion is that Ross mistook the blue whale for the right whale.[3]

Modern Whaling in the Antarctic

During 1901–1903 Captain C. A. Larsen, as commander of Otto Nordenskjöld's ship *Antarctic*, had again an opportunity of studying the occurrence of whales around South Georgia and the South Shetlands. As a consequence he was led to the formation of the first company for whaling in the southern seas, the Compañia Argentina de Pesca, organized in Buenos Aires in 1904 with Argentine capital and Norwegian equipment, personnel, and technique. Larsen erected a station at Grytviken, on the northeastern side of South Georgia, and began whaling in adjacent waters in December, 1904.

The first Norwegian whaling expedition to the southern seas consisted of the floating factory *Admiralen* already mentioned and of two whale catchers belonging to the Örnen Company, whose manager, C. Christensen, was another of the grand old men of the Norwegian industry. Some hunting was accomplished on the Falkland Islands grounds, thereafter for a month's time and under difficult conditions about Admiralty Bay in the South Shetlands, and then again for a short time about the Falkland Islands. On the first of June the expedition was back in Sandefjord with a full catch. Thenceforth began a rapid expansion of the industry, concentrated on South Georgia and the South Shetlands, the nearest and most accessible groups of islands in the subantarctic regions.

Whaling in the Antarctic is now carried on from Patagonia and the islands on the west side of Graham Land eastward along the border of the pack ice to the longitude of Cape Town, or, in other words, between 80° W. and 20° E., and around South Georgia, the South Shetlands, South Orkneys, and the South Sandwich Islands. It is also prosecuted outside the Ross Sea about the Balleny Islands and in Ross Sea.

South Georgia, the South Shetlands, the South Sandwich Islands, and the South Orkneys are dependencies of the Falkland Islands, and whaling in their waters is controlled by the British government. It can be carried on only by license, purchasable for a fixed sum, which regulates the number of the vessels to be employed.[4] There are also penalties for infringement of the regulations, and an export duty is levied on whale oil and guano. This duty has greatly increased,

[3] H. J. Bull: The Cruise of the 'Antarctic' to the South Polar Regions, London and New York, 1896, p. 218.

[4] Report of the Interdepartmental Committee on Research and Development in the Dependencies of the Falkland Islands, Cmd. 657, 1920. The revenue is devoted in part to development of the industry.

especially since 1919. The licenses, the number of which was limited to 7 for South Georgia and 8 for the South Shetlands, were all purchased in 1911. Later, two more licenses were granted to British companies for the South Shetlands. The licenses, which originally ran for 21 years and were renewed provisionally for 5 years in 1928, give each one the right to use one factory ship and three whale catchers. Of the seven licenses for South Georgia, two are British, one Argentine, and four Norwegian. Of the ten licenses for the South Shetlands, three are British and the remainder Norwegian. Whaling has also been carried on by a few Norwegian companies at the South Orkneys during the years 1911 to 1915, and a company has operated there during the last three years. In spite of the fact that the ice conditions are worse here and the season shorter, the results have been good.

FIG. 10—Whale catcher returning to Deception Island after a successful day's hunt. (Photograph by Sir Hubert Wilkins; copyright by *New York American* and Universal Service.)

It may be noted that there has always existed a good understanding between the whalers and the British colonial officials, who have been considerate of the opinions and suggestions of the whalers regarding laws for the best use of the catch and for conservation of the whale.

Captain Larsen, who in 1904 began the whaling from South Georgia, was also the first to hunt blue whale in the Ross Sea where this kind of whale was found by H. J. Bull's expedition. With the floating factory *Sir James Clark Ross* (12,450 gross tonnage) and 5 whale catchers Larsen spent the season 1923–1924 in the Ross Sea. To gain the open water of Ross Sea he had to cross (December 13–20) a belt of pack ice 600 miles in width. A daring and risky undertaking it was:

FIG. 11

FIG. 12

FIG. 13

FIG. 11—The shore whaling station at Deception Island, early November, 1928.
FIG. 12—Small motor boat towing a whale to the slipway.
FIG. 13—Whale bones strewn along the beach, Deception Island. (Photographs 11–13 by Sir Hubert Wilkins; copyright by *New York American* and Universal Service.)

FIG. 14

FIG. 15

FIG. 16

FIG. 14—Flensing platform of the shore whaling station at Deception Island.
FIG. 15—Whale being hauled onto the flensing platform.
FIG. 16—Stripping the blubber: the second strip. (Photographs 14–16 by Sir Hubert Wilkins; copyright by *New York American* and Universal Service.)

however, all went well.[5] The next year Larsen returned. He died on his ship in the Ross Sea on December 8, but his successful work has been continued. In the season 1926–1927 three floating factories with fifteen whale boats were operating here.[6] The Norwegian whaling fleet in the Antarctic this last season, 1928–1929, worked with three land stations, about 85 whale catchers, 24 floating factories. In April the *C. A. Larsen* and the *Sir James Clark Ross* from the Ross Sea docked in New York carrying cargo valued at $2,000,000 and $1,500,000 respectively. The former had caught 761 whales, the latter 545. The oil obtained was 75,000 and 51,000 barrels respectively, destined for American soap factories.[7]

Recent Developments in the Industry

Almost all companies in the southern seas began whaling with floating factories, still used by most of them. In the beginning these factories were steamers of 2300 to 6000 gross tonnage, since only the blubber of the whale was used. For a more rational use of the carcass the equipment has been constantly improved, and the factories have been increased in size up to 12,000 gross tonnage. While the boiled remains of meat and bone at the land stations are dried and prepared for fodder, bone flour, and guano, the preparation of these products is difficult on the floating factories since it requires large space and is at present not profitable. And it is not fully free from fire risks.

At the same time land stations have been erected. Of these there are now one in the South Shetlands, on Deception Island, and five on the northeastern side of South Georgia. They have besides guano factories, repair shops, slipways, warehouses, oil tanks, water supply, and electric light. They have also accommodations for comfortable living and for social gatherings.

The hunting season at South Georgia lasts from the end of September till the middle of May, at the South Shetlands from the latter part of November till the end of April. The floating factories therefore leave Norway between the middle of August and the end of September and are back again between May and July. The whale catchers in this section are laid up and repaired at South Georgia, Montevideo, or Cape Town: the Ross Sea catchers are laid up at Stewart Island, N. Z.

Since the humpback whale is most easily caught, it was the

[5] An account of the voyage with geological, meteorological, and zoölogical observations is given by Ludwig Kohl: Zur grossen Eismauer des Südpols: Eine Fahrt mit norwegischen Walfischfängern, Stuttgart, 1926. See also the narrative of A. T. Villiers: Whaling in the Frozen Seas, Indianapolis, 1925.

[6] The author was on the N. T. Nielsen-Alonso of the Polaris company in 1926–1927. See his book "Jorden rundt efter Blåhvalen," Oslo, 1927.

[7] The commercial uses of whale oil—for soap making, as a substitute for tallow, lard, and margarine, as a lubricant, etc. are discussed in the Report on the Dependencies of the Falkland Islands; see footnote 4.

chief kind hunted before 1912. As the supply of humpback had decreased decidedly at this time, blue whale and finback have been hunted since then, the blue whale usually in the first part of the season, and finback in the latter part.

As was observed in the early history of whaling, so it has been noticed in the Antarctic that the whale extends its area farther from

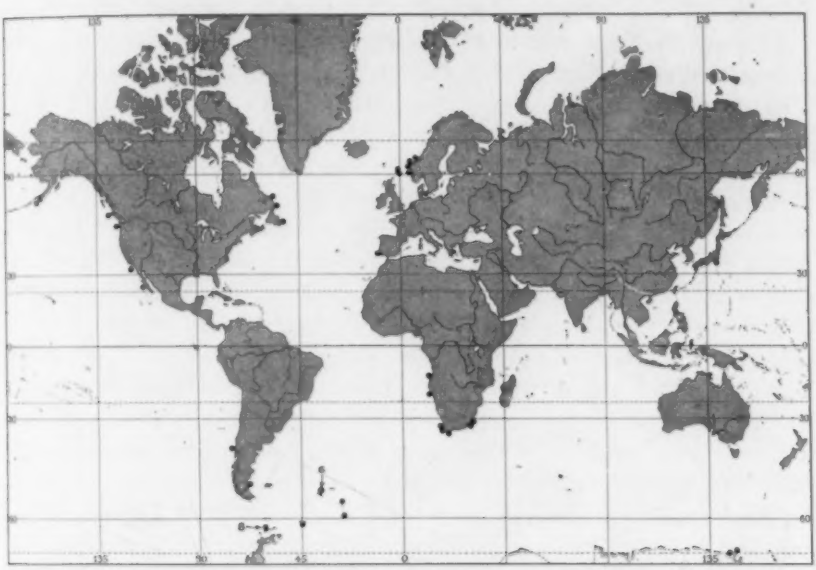

FIG. 17—Map showing the stations of the whaling companies operating in 1928–1929. (After the Register of the Whaling Fleet, Whalers' Mutual Insurance Association, Sandefjord, 1928.)

land, not only because winds and currents may drive the food out to sea but also because of the hunting. This again means smaller returns because of the long tow to the stations. It has therefore been necessary to make the whaling steamers larger and more seaworthy and equip them with stronger engines. By 1912 the power had been increased to about 500 horse power; by 1924 to 800 horse power; and since then, in a few boats, to 1000 to 1200. One company last year had a boat of 1500 horse power and has one of 1650 horse power under construction.

Parallel with this development of the catchers there has been an evolution in the floating factories. Originally the factories were designed for operation in a sheltered anchorage. Latterly some of them have carried out operations to a certain extent or exclusively in the open sea.

Companies with stations in the South Shetlands were compelled to take up whaling in the ice when conditions in the early part of the season prevented them from getting back to the stations with their catch. During the last few years ice whaling has been extended more

and more over the summer and the autumn and, in the present season (1928–1929), has been carried on as long as the whalers could by entering the pack ice find smooth enough water to permit flensing of the whales at the side of the ship. Since the pack ice is melted or drifted away eastward in the latter half of February, and the nights then become dark and the weather stormy, the expeditions that have concessions seek their way by this time to their stations.

However, there are also whaling companies that have no concessions, the so-called pelagic companies. They carry out all operations in the open sea without connection with any station and carry with them coal and a fresh-water supply for the entire trip. When the companies that have concessions leave the ice for their stations in order to extend the hunting period, the pelagic expeditions return home. The fact that the floating factories have been equipped with a slip for hauling the entire whale aboard has more than anything else contributed to the expansion of pelagic whaling. The whale can consequently be treated aboard instead of at the side of the ship, and this not only in smooth water but in fairly rough seas. These factories are of still larger tonnage—12,000 to 18,000 gross. During the next season there will be a floating factory of 22,000 gross tonnage, carrying 7 whale catchers. In 1925–1926 there was only one pelagic factory: there were eight in 1928–1929.

All land and floating stations and whale catchers have wireless, and the catchers and several floating factories have also direction finders. The latter have special radio operators. On the catchers usually the captain or the mate operates the radio. Radios and direction finders are essential instruments for the pelagic whalers.

If in earlier times it was an achievement of the first order to circle the globe with the small whaleboats, it is no less an achievement to pull up onto the deck in open sea the blue whale, sometimes as much as 100 feet in length, the largest mammal living.

Economy of Whaling Industry

From 1906 to 1927 there has been produced at South Georgia 3,830,000 barrels of oil valued at 400,000,000 kroner and at the South Shetlands 2,645,000 barrels of oil valued at 280,000,000 kroner. The total for the Falkland Islands Dependencies is thus 6,475,000 barrels valued at 680,000,000 kroner. An addition from the Ross Dependency (1924–1927) of 199,000 barrels of oil valued at 20,000,000 kroner brings the total for the Antarctic to 6,674,000 barrels of oil valued at 700,000,000 kroner. The Antarctic production of 1928–1929 was about 1,600,000 barrels, which exceeded by 200,000 barrels the entire world production of the previous season.

The finest whale oil is numbers 0 and 1 oil with less than two per

cent free fatty acid. In 1924–1925 prices of this oil averaged £35 3s. per ton (about 6 barrels of 170 kilograms); in 1926–1927, £27 10s., and in 1928–1929, £30. The prices per ton of the higher numbers of oil decrease by a few pounds sterling for each number. For instance, number 2 oil costs about £3 less than numbers 0 and 1 oil, and number 3 oil costs about £3 less than number 2 oil.

The non-Norwegian companies have non-Norwegian direction and capital but Norwegian technique and personnel. All personnel are paid with board, salary per month, and part of the catch. This last is paid to the men of the whaleboats per whale according to the kind, and to the men at the land and floating stations per barrel of boiled oil. The captains on the factory ships, the captains of the whale catchers, and the gunners are also paid with wages and part of the catch according to a special agreement. The captains of the factory ships are also as a rule heads of the whole expedition. But in some cases the gunner of one of the whale catchers is the head. The captains of the whale catchers are usually also gunners; but in some cases the mate or a special man, not a member of the crew, is the gunner.

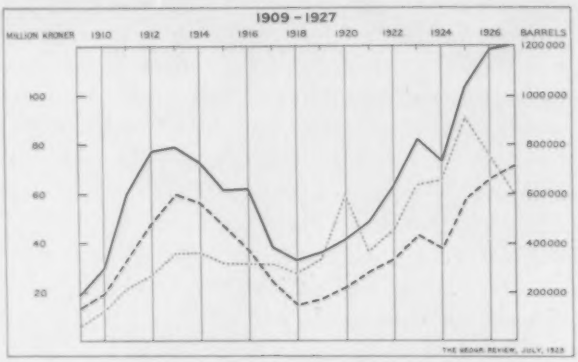

FIG. 18—The whaling industry, 1909–1927. The solid line represents the world's catch in barrels; the dashed line, the Norwegian catch in barrels; the dotted line, the value of the Norwegian catch. (After the Register of the Whaling Fleet, Whalers' Mutual Insurance Association, Sandefjord, 1928.)

A whaling expedition to the southern seas, consisting of a factory ship and three whale catchers, has 80 to 180 men for the ship and 11 to 13 for each catcher. Expenses for an expedition of ten months' duration is from one and a half to three million kroner. In this amount is included the outlay for the yearly inspection and repairs after the heavy wear of the material in sea and ice. On the whole, whaling is a risky business and does not return more than a modest interest on the invested capital. All equipment in the industry is exposed to such wear and tear that it is necessary to set aside larger sums than in most other industries for replacement, especially of whale catchers, which are frequently worn out and antiquated after a few years' use.

In the Antarctic more than 20,000 whales have been killed annually during recent years. In a single year the Antarctic catch

represents about 70 per cent of the catch in all parts of the globe. It is fortunate for the preservation of the whale that modern whaling in distinction from the old requires so much capital that a relatively small decrease in the supply of whales will cause a cessation of the industry before it becomes unprofitable or the fisheries are exhausted.

Contribution to Science by Whaling

After his second circling of the globe (1772–1775) between 50° and 70° S., James Cook wrote that there was not the slightest possibility of the existence of a continent here except near the pole and outside the sailing limits. His journey represents the beginning of south polar exploration. A second stage (1812–1843) was introduced by American and English whaling and sealing expeditions. It was completed by the French expedition of Dumont d'Urville in 1838–1840, the American expedition of Charles Wilkes in 1838–1841, and the English expedition of James Clark Ross in 1839–1843.

After these expeditions there were no more for fifty years. Then Norwegian and Scottish whalers introduced the third period (1892–1914). The whaling expedition (1893–1894) of the Norwegian Captain Larsen, already referred to, judged from a purely geographical point of view in comparison with other whaling trips, may be regarded as "one of the richest in results ever undertaken," whether to Arctic or Antarctic regions.[8]

Larsen in the *Jason* made his way southward along the east side of Graham Land, soon reached the highest latitude of Ross at 64° S., crossed the Antarctic Circle, and on December 6, 1893, reached 68° 10′ S., the highest latitude in the eastern Graham Land region until Wilkins' flight in 1928. Larsen discovered much new land and on his return a number of islands, several of which have active volcanoes. He landed on the South Orkneys, Seymour Island, and Louis Philippe Land and brought back in his collections the first fossils from the Antarctic. Contemporaneous with Larsen on his expedition of 1893–1894 another Norwegian whaler, Captain C. J. Evensen, with the *Hertha* forced his way southward along the west side of Graham Land and reached a still higher latitude than Larsen on the east side, namely 69° 10′ S.

H. J. Bull's whaling expedition with the *Antarctic* in 1895 was the first to the east Antarctic after that of Ross in 1842. He was no more successful in finding right whales than Larsen, but, as Sir John Murray has said,[9] the poor economic return of Bull's expedition was fully compensated by the fact that it reached to and made the first

[8] Otto Nordenskjöld and J. G. Andersson: Antarctica, or Two Years Amongst the Ice of the South Pole, London and New York, 1905, p. 77.

[9] In a letter to H. J. Bull. See also H. R. Mill, *op. cit.*, p. 382.

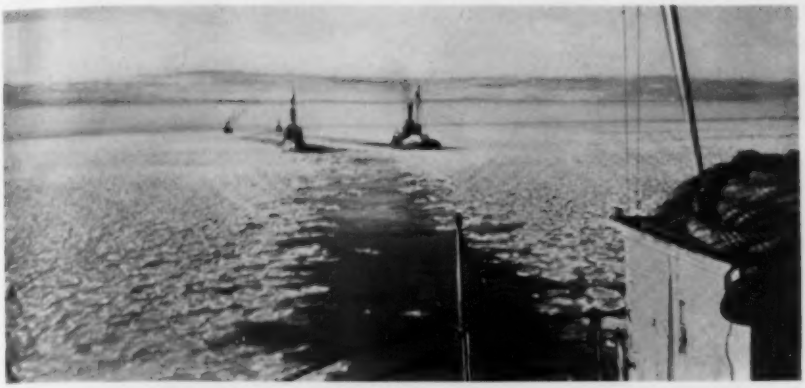

FIG. 19

FIG. 20

FIG. 21

FIG. 19—New ice beginning to form is the signal for the whalers to leave Ross Sea, 1927.

FIG. 20—The floating factory *N. T. Nielsen-Alonso* (*Polaris*) in the pack ice outside of Ross Sea, December, 1926.

FIG. 21—The floating factory *Falk* operating in the ice, 1927.

landing in South Victoria Land and found that ice-free waters apparently occur normally south of the pack ice.

These Norwegian whaling expeditions described above are of fundamental importance not only for the Norwegian whaling industry but also for modern south polar exploration. Our knowledge of whales, their migrations and propagation, is due to the whalers. It is part of the work of the gunners to know the animals and their habits, to find them and follow them until they are killed. The Norwegian whalers early discovered that whales both in the northern and the southern seas migrate in spring to colder regions and in autumn to warmer regions. They knew that the migrations were undertaken to obtain their food, drifting organisms which in spring develop in such enormous numbers as often to color the water.

At the same time they observed that the migrations are connected with breeding, the bearing of the young taking place in the warmer waters. As far as is known, breeding migrations are the rule, especially as regards the humpback, and also as regards the blue whale and finback, in spite of the fact that the observed embryos suggest that the whale has no fixed mating season.

Since food is scarce in temperate and warm seas the animals grow lean before they return in spring to the abundance of the polar seas. From the opportunities the whalers have had to follow the migrations, they believe that the whale as a rule does not migrate from the southern hemisphere to the northern, or vice versa. From numerous measurements it is evident that the animals are larger in the southern seas than in the northern. It is necessary to study the conditions of existence of the whale and its food from the Arctic to the Antarctic and during different seasons in order to know and explain the animal's distribution; and this knowledge is necessary for a pertinent discussion of the international problem of the future of the whale and the whaling industry.

In 1923 the so-called Discovery Committee was appointed to follow up recommendations of the Inter-Departmental Committee on Research and Development in the Falkland Islands (1920). Captain Scott's old ship, the *Discovery*, was acquired for field study in the southern waters.[10] Agreement was made between the British Discovery Committee and the Association of Norwegian Whaling Companies that while the *Discovery* expedition studied the whales around the islands in the southern seas from which whaling operations are carried on the Norwegians should study the whales in Davis Strait and the Norwegian Sea. These studies have shown that the animals that form the food of the whales occur along the edges

[10] See A. C. Hardy: The Work of the Royal Research Ship "Discovery" in the Dependencies of the Falkland Islands, *Geogr. Journ.*, Vol. 72, 1928, pp. 209–234; also reports in *Nature*, Vol. 118, 1926, pp. 628–632, and Vol. 121, 1928, pp. 795–799.

of the continental shelf and on the banks in the polar seas, not in the deep sea beyond.[11] The plankton develops in masses when the warm saline water enters the cold water at the edge of the continental shelf and on the banks. So far the *Discovery* researches indicate that the South Georgia whales—blue, fin, and humpback—feed exclusively upon one organism, a shrimp-like creature (*Euphausia superba*), the ***krill*** of the Norwegians.

In furtherance of the study of distribution Consul Lars Christensen of Sandefjord, in the beginning of 1927, sent one of his whaling vessels, the *Odd I*, from the South Shetlands westward to Peter I Island and, in 1927–1928, an expedition in the *Norvegia* (285 tons register) to seek new areas for whale hunting and for scientific study. The expedition landed on Bouvet Island, which was annexed for Norway, and worked here for a month. Thereafter it continued southward to the ice border and westward to South Georgia, where the cruise had to be discontinued for repairs to the ship as a result of running aground at Bouvet Island. Two naturalists of the *Norvegia* continued their studies on South Georgia till the end of the season in the middle of March; two other naturalists from Norway joined the expedition here, having earlier worked in the South Shetlands. During the season of 1928–1929 the *Norvegia* has been on an expedition to Bouvet Island, the South Shetlands, and Peter I Island, which was annexed. Thence the expedition proceeded to 59° 40′ S. and 141° W., and on the return to the South Shetlands, looked in vain for Dougherty Island, reported by Dougherty, Stannard, Keates, and Swain.

The Norwegian whaling towns also are making scientific collections. Tönsberg has a polar museum, and since 1917 the Whaling Museum of Commander C. Christensen has been installed in Sandefjord. While the whalers use the charts of the British Admiralty compiled and corrected from the latest information in the Hydrographic Office, latterly Norwegian maps are available for certain areas—maps compiled for the Whalers' Mutual Insurance Association and edited by Commander Christensen's Whaling Museum on the basis of all existing material supplemented by reports and information from the whalers. The Whalers' Mutual Insurance Association was established in Sandefjord in 1911, and the office of the Association of Norwegian Whaling Companies in 1912.[12] Their periodical, the *Norwegian Whaling Gazette*, is edited with the same reliability as the earlier American *Whalemen's Shipping List* in New Bedford (1843–1914).

[11] Johan Hjort and J. T. Ruud: Whaling and Fishing in the North Atlantic. *Rapports et Procès-verbaux, Conseil Int'l. pour l'Exploration de la Mer*, Vol. 56, Copenhagen, 1929. (In preparation.)

[12] In May, 1929, it became the Association of Whaling Companies, including both Norwegian and foreign companies.

THE ITALIAN COLONIES

Giotto Dainelli
University of Florence

FIG. 1—The Italian Colonies.

NATIONAL economic problems, accentuated since the end of the World War, have stimulated among the Italians the growth of what might be called a colonial conscience. On the one hand we have the rising standard of living among laboring classes, the unforeseen and serious curtailment of emigration, added to a population already very dense and with an increasingly rapid rate of growth; on the other hand we have the decline in the value of the lira, the very moderate per capita wealth of the nation, the insufficiency of agricultural production, and the almost total lack of raw materials necessary for industrial life.

Thus has arisen the renewed impetus given to the construction of artificial reservoirs for the production of electric energy to relieve our dependence on foreign coal.[1] Similarly attempts are being made to improve the cereal cultivation of the home fields, and an extensive program of land reclamation has been inaugurated which ought, in the course of a few years, to put in production lands heretofore waste. Methodical researches are also being undertaken into the mineral resources, and the work of propaganda abroad has in view competition with other nations in the marketing of manufactures. Of a piece with these is the aid given to the mercantile marine both as regards passenger and goods traffic.

There enters into this program also the exploitation of the colonial possessions. The first stage in the development of the Italian colonies —the long first period of acquisition and pacification—has been concluded. This has been a matter of government action and has had little interest for the citizens at large. A number of geographers and naturalists had already turned their attention to the colonies, but the public was generally ignorant of their studies. Today the situation is changed: a new period has begun—that of exploitation. Here it is well to present in outline the existing knowledge of our colonies.

[1] W. O. Blanchard: White Coal in Italian Industry, *Geogr. Rev.*, Vol. 18, 1928, pp. 261–273.

There is available today quite a large body of information on the Italian colonies. Regarding it two observations may be made. In the first instance the field studies have been made primarily not so much by geographers as by naturalists and especially by geologists. In the second instance the greater number of workers have come from the city of Florence, in which still survives the ancient and famous tradition of naturalists and travelers.

The state also has contributed to the progress of colonial research, especially in its surveys. There exist good large-scale maps of the greater part of the territory of Eritrea and the coastal zone of Libya; for the remainder of these two colonies and for Somalia there are, however, only general maps or original traverses which are waiting compilation. But, broadly speaking, we already have available enough cartographic material to serve as a basis for generalized distributional studies. On the natural vegetation, the indigenous culture, on the possibility of the introduction of plants of industrial value, and on related climatic conditions, data have been gathered by the state agricultural offices. Mention too should be made of the censuses of population and agriculture taken by the government of Eritrea; for Somalia and Libya at the present time there exist only estimates or enumerations more limited regionally.

The principal field studies may now be briefly indicated. For Eritrea—but only for a limited part of it—a first geological study was carried out by L. Baldacci.[2] Later work was done by G. Dainelli and O. Marinelli,[3] who carried out not only a geological survey of a very large part of the territory but also more extended studies of a geographical nature, including the volcanic phenomena, the morphological complex, with special attention to the great depression of Dancalia; contributions towards the geological history of the Red Sea and of East Africa; observations on climate and the climatic zones; and ethnographical studies, including investigation of the ruins of the Axumite period. Along with them L. Loria and A. Mochi (also of Florence) made rich ethnographical collections[4] and gathered anthropometric data. Subsequently the main contribution to our knowledge of this colony was made by P. Vinassa de Regny with a geological study of a part of coastal Dancalia.[5]

Scientific studies of Italian Somaliland—southern as well as northern—are due almost exclusively to G. Stefanini (of Florence): he completed the geological survey of a large part of that colony with

[2] Osservazioni fatte nella Colonia Eritrea, *Mem. Descr. Carta Geol. Italia*, Vol. 4, 1891, Rome. See also the bibliography by Giuseppe Stefanini and Carlo de Stefani: Bibliographie des travaux des géologues italiens sur l'Afrique, *Comptes Rendus Congrès Géol. Internatl. XIII (en Belgique, 1922)*, fasc. 2, Liége, 1925, pp. 1073–1086.

[3] Giotto Dainelli and Olinto Marinelli: Cenni sommarii sopra i risultati scientifici di un viaggio nella Colonia Eritrea, *Atti VI Congr. Geogr. Italiano*, Vol. 2, Venice, 1908, pp. 212–237. *Idem:* Risultati scientifici di un viaggio nella Colonia Eritrea, Florence, 1912.

[4] The collection is in the Ethnographical Museum of Florence.

[5] Paolo Vinassa de Regny: Dancalia, Rome, 1923.

results of a most novel character;[6] he has given us also an effective picture of its morphology and in particular of its hydrography.[7] Among his successors, G. Paoli and N. Puccioni (of Florence)[8] respectively devoted themselves to biological and anthropological investigations.

Libya—as it was nearer to Italy and was conquered during a period in which interest in colonial problems was beginning to be felt—has provoked more intense researches, although these have been limited almost entirely to the coastal zone. Only a short time after the occupation a governmental mission, and another sent out by a special committee from Florence, carried out careful work in almost the whole of the northern zone of Tripolitania between the first plateaus and the sea. The geologist of the first mission was C. F. Parona,[9] and of the second A. Stella; but around them and acting in coöperation with them was a body of workers, for the most part botanists and agricultural experts, inasmuch as the principal objective of the two missions was the study of agricultural possibilities in the new colonial territory.

For Cyrenaica, as is well known, there exists a geological study by J. W. Gregory;[10] a later study by G. Feruglio[11] is devoted to karst phenomena, but—independent of minor studies of local character, among which perhaps the most interesting is one on the geology and morphology of the environs of Tobruk carried on by C. Migliorini[12] (of Florence)—there is available a monographic description by O. Marinelli, G. Stefanini, and E. Ricci.[13]

Of interior Libya, at the present time we know little that is based on scientific research; solely, it might be said, for the recently pacified oasis of Jaghbub, which has been studied by A. Desio (of Florence).[14]

Thus, notwithstanding the gaps which still remain, the scientific exploration of our Italian colonies has progressed far enough to serve as a basis for works of a practical nature, which here and there have been initiated, particularly in Somalia where the great example has been given by His Royal Highness the Duke of the Abruzzi.

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[6] Giuseppe Stefanini: Osservazioni geologiche nella Somalia italiana meridionale, *Boll. Soc. Geol Italiana*, Vol. 32, Rome, 1913, pp. 398–400.

[7] Missione Stefanini-Paoli: Ricerche idrogeologiche, botaniche ed entomologiche fatte nella Somalia italiana meridionale (1913), Florence, 1916.

[8] Giuseppe Stefanini and Nello Puccioni: Notizie preliminari sui principali risultati della Missione della Reale Società Geografica in Somalia (1924), *Boll. Reale Soc. Geogr. Italiana*, Ser. 6, Vol. 3, 1926, pp. 12–76.

[9] Ministero delle Colonie: La Tripolitania Settentrionale, Rome, 1913.

[10] J. W. Gregory: The Geology of Cyrenaica, *Quart. Journ. Geol. Soc. of London*, Vol. 67, 1910, pp. 572–615. *Idem:* Cyrenaica, *Geogr. Journ.*, Vol. 47, 1916, pp. 321–345.

[11] G. Feruglio: I fenomeni carsici della Cirenaica, *Mondo Sotterr.*, Vol. 7, Udine, 1912. See also F. Mühlhofer: Cyrenaika, Vienna, 1923.

[12] C. I. Migliorini: Sulla geologia dei dintorni di Tobruk, *Atti Reale Accad. dei Lincei*, Ser. 5, *Rendiconti, Cl. di fis., mat. e nat.*, Vol. 23, Rome, 1914, pp. 833–839.

[13] Olinto Marinelli, edit.: La Cirenaica: geografica, economica, politica, Milan, 1922.

[14] Ardito Desio: Notizie geologiche e geografiche sull' Oasi de Giarabùb e sul Deserto Libico, *Boll. Reale Soc. Geogr. Italiana*, Ser. 6, Vol. 4, 1927, pp. 115–145 and 227–255. *Idem:* La morfologia; la geologia (Risultati scientifici della Missione alla Oasi di Giarabùb (1926–1927)), *Memorie Reale Soc. Geogr. Italiana*, 1928, pp. 1–163.

The Physical Bases: Relief

We cannot compare any of our colonies to the French possessions of Mediterranean Africa as regards relief. From Tunisia, through Algeria to Morocco, there runs parallel to the sea the chain of the Atlas, a true mountain chain belonging tectonically to southern Europe. Very different is the mountainous relief of the whole remainder of Africa. If we except the mountains which extend from the plain of Dancalia to the zone of the great equatorial lakes and betray their volcanic nature in their more or less well preserved cones, the African landscape from Egypt to the Cape is uniform, even to the point of monotony. Uplift has produced the series of great plateaus that give the continent its characteristic physiognomy. It is exhibited in Tripolitania, where the rocky plateau of Garian slopes down with a gentle gradient to spread itself out into the desert of the Hammada-el-Homra; and in the plateau of Cyrenaica, which, rising practically straight from the sea, declines gradually towards the steppes farther to the south. Eritrea makes a seeming exception to any one approaching Massawa, where there comes into sight a high mountainous slope cut by wide, deep valleys; but when you climb to the crest you come out at the edge of a vast plateau, the level surface of Asmara. And throughout the whole of Abyssinia, gigantic acropolis of East Africa, there extends the plateau, here more and here less elevated as if it had been cut into immense terraces; and the mountains themselves, that is to say the fragmented borders—only details of the landscape but yet distinguished in its infinite uniformity—have themselves flat-topped summits. And beyond Shoa the Abyssinian plateau descends by great terraces towards the Indian Ocean, the last of these spreading out gently to the alluvial plains of the Webi Shebeli and the Juba in Italian Somalia. Thus arises the similarity of the topography in our African colonies: the differences lie in the altitudes to which successive plateau blocks rise above one another—a few hundreds of meters in Libya and Somalia and some thousands of meters in Eritrea. The more elevated the relief the more intense naturally the work of the rivers. In Eritrea alone does stream erosion notably affect the landscape.

In Somalia and in Libya—where the uplift was not so great and took place at a later date—the terrain is geologically more youthful. In Libya the rock formations, at least in the coastal zone which is best known, are of Tertiary age; with, in Tripolitania, an outcropping of younger Secondaries. In Somalia the rocky plateau which inclines towards the coastal plains is composed in its greater part of strata entirely of Secondary age, although old crystallines also outcrop. In Eritrea, where the uplift has been very much more intense, the whole plateau is constituted of this basement of ancient crystalline rocks on which rest Secondary strata. Moreover, in Eritrea geological conditions are particularly complicated by the great extension and thick-

FIG. 2

FIG. 3

FIG. 4

FIG. 2—The scarp of the plateau which rises abruptly from the sea, Cyrenaica.
FIG. 3—Olive cultivation, Msellata, Tripolitania.
FIG. 4—Grassy steppe, Tripolitania.

FIG. 5

FIG. 6

FIG. 7

FIG. 5—The coast plain, Eritrea.
FIG. 6—The plateau, Eritrea.
FIG. 7—The Setit River, here forming the boundary between Eritrea and Abyssinia.

ness of volcanic material both old and recent; while in Libya and Somalia evidences of similar eruptive phenomena are rare and limited.

Climates and Water Resources Compared

More effective in diversifying the landscape of our colonies is the difference in climate from one to another. The coastal border of Libya has a typically Mediterranean climate. In winter the prevailing south winds tend to preserve warmth; in summer the prevailing north winds to prevent excessive heat. The mean temperature, approximately 20° C., is not unlike that of the greater part of southern Italy itself, with the exception that the diurnal range is fairly constant in the neighborhood of 7° throughout the year, whereas in Sicily it is much greater in summer and less in winter. Also the mean humidity in the coastal zone of Libya is approximately equal to that of Sicily; but, while in the latter it gets very low in summer, in the former it remains fairly high, provoking a very abundant formation of dew with a direct advantage to vegetation since in a certain measure it takes the place of the rains which are not plentiful and are concentrated in the winter period. Thus in comparison with Sicily coastal Libya presents certain advantages as regards agriculture. In Tripolitania in the steppe zone behind the coastal oasis the mean temperature rises, the diurnal range increases, and rains tend to diminish. These characteristics are accentuated the farther one goes into the interior except for a break corresponding to the edge of the Garian plateau; beyond this point one passes rapidly to climatic conditions more and more characteristic of the belt of African deserts.

The same transition from one climate to another is found in Cyrenaica with this difference, that between the seashore and the plateau escarpment the intermediate steppe zone is lacking. Transition is much more rapid; and, furthermore, the nearness of the plateau to the sea results in heavier precipitation, which is reflected in the vegetation; brush and thicket have a notable extension here although they are unknown on the Tripolitanian plateau. The topographic difference between the two colonies also has its effect on the hydrographic régime. The plateaus as a whole are of limestone rock. In Cyrenaica proximity to the sea results in the issuance of the subterranean waters near the base of the rocky escarpment in the form of springs of considerable flow. In Tripolitania, on the other hand, the aquiferous layer presumably passes under the superficial covering of the steppe zone as far as the coastal oases. As this layer approaches the coast it nears the surface until it becomes of such slight depth that arboreal vegetation reaches it with its roots and men reach it primitively with their wells.

Italian Somalia is characterized by a dry hot climate. It falls

under the direct influence of the monsoon régime from the southwest during the summer and from the northeast during the winter; there are two intermediate periods of calms with which coincide the rainy seasons. The latitude justifies a mean temperature on the seacoast much higher than in Libya—between 25° and 27° C.—but as one goes

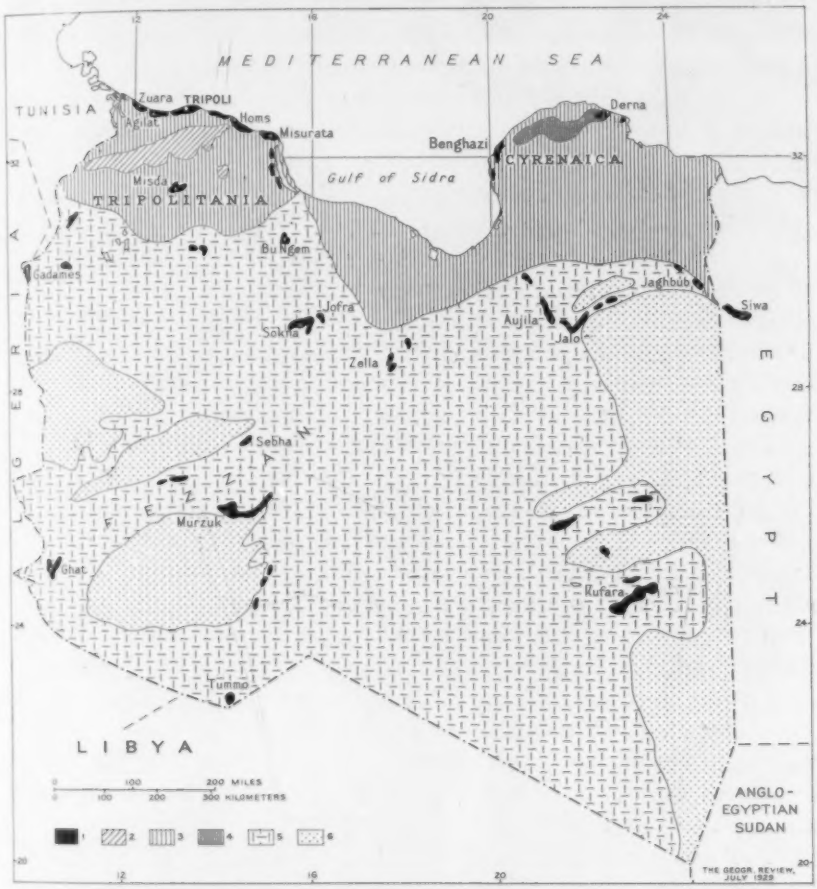

FIG. 8—Map of Libya (Tripolitania and Cyrenaica). The numbers have reference: 1, cultivated land for the most part under irrigation, with palm groves, fruit groves, truck farming (gardens in the littoral zone, oases in the interior); 2, primarily dry farming, olives and figs, locally barley; 3, steppes and *macchia* scrub exploited as pasture, local barley cultivation; 4, woods and dense *macchia* growth; 5, rocky desert (*hammada*); pebbly desert (*serir*); 6, sandy desert (*edeien*). Scale 1:14,000,000.

toward the interior, it rises notably; nor is the moderating influence of high altitude felt within the limits of the colony. Oscillations of temperature are not great, but the humidity is high, especially on the seaboard, which increases the sensible temperature. The rainfall, scant in the coastal fringe, increases towards the interior, though naturally it is much greater westward; for the colony fortunately is part of an extensive region which has its limits in the mountains of

Arusi and Harar, rising more than 3000 meters. Hence the hydrographic régime is only to a very small degree dependent upon the local climate. It is this high zone lying outside of Italian Somalia which contributes its abundant waters from the territory of Mijertini in the north to the recently acquired territory known as Trans-Juba in the south. Greatest and best known are the Juba and the Webi Shebeli; the former with a flow of about 800 cubic meters per second near Bardera, the second with 200 cubic meters near Afgoi.

While the volume of these streams is seriously diminished by the intense evaporation of the plains and their broad-spreading channels, nevertheless the Juba is navigable from its mouth to Bardera; and it might without great cost or difficulty be improved and rendered navigable over a longer distance. However that may be, the two rivers constitute the true wealth of the colony by permitting the construction of irrigation works on a great scale.

The same plain, moreover, whether through seepage from the rivers or directly from the rains, has a water table reached by the old wells dug by the natives; and a first investigation has already revealed that it overlies a deeper level of artesian water towards the interior.

Conditions in Eritrea appear more complicated. The thermal equator passes approximately through Massawa; but, if here and along the coast as a whole there are characteristic temperatures of 45° to 50°, beginning a short distance from the seaboard the temperature sensibly diminishes until on the margins of the plateau and for the greater part of its extent the mean temperature in general is lower than 20°, although with very marked diurnal oscillations. There is thus a pronounced and rapid transition between the intense periodic heat along the coast and the moderate, eternal spring-like climate of the plateau. The plateau, however, slopes towards the west down to the Sudanese plains where the maximum temperature values are similar to those on the coast, while the minimum values are lower and the air is much drier so that the heat is more endurable.

The plateau also constitutes a boundary between regions with opposite types of rainfall. On the west there are found rains of a tropical régime characterized by violent and brief downfalls and divided into a spring period of little rains and a summer period of great rains, the total not usually exceeding 500 millimeters a year. From the east, that is from the Red Sea, come winter rains, less abundant but gentler and in virtue of that quality possibly more valuable. They increase in intensity from the low coastal plain to the upper edge of the plateau; and here where the two opposing régimes meet there is a marginal zone benefited from both alike. On the plateau, moreover, the low morning temperatures produce such a heavy dew that the roofs actually drip; and from the low coastal plain there rise currents of air laden with moisture which at about

FIG. 9

FIG. 10

FIG. 11

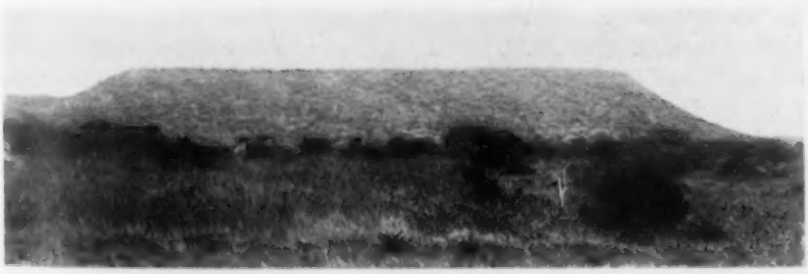

FIG. 12

FIG. 9—The Eritrean plateau, basalt overlying granite.

FIG. 10—The Ambe of Senafè and the Ambe Terica in southern Eritrea. The former is trachyte, the latter is basalt. The isolated relief of the plateau *(ambe)* is constituted by eruptive rocks.

FIG. 11—The alluvial lowland, Somalia.

FIG. 12—Interior terrace, Somalia.

1500 meters altitude cause the daily formation of fine clouds to which is due the locally vigorous arboreal and shrub-like vegetation along a belt not far below the rim of the plateau.

In spite of these comparatively favorable conditions, the Eritrean plateau appears poor in water because the rains rapidly penetrate the ground; nor do they reappear in the form of springs on the plateau. Springs, however, feed nearly all the valleys facing the Sudan and the Red Sea, constituting rivers some of which—like the Gash and

FIG. 13—The Juba River, Somalia.

the Setit on the southwestern borders—have considerable and even very great flow at the time of the rains. In their lower courses the rivers become impoverished, in some cases disappearing altogether at the surface, though forming a continuous water level in the alluvial or sandy plain which extends from the base of the escarpment of the plateau in the Sudan and along the shore of the Red Sea.

Each of our African colonies thus has its particular climatic and hydrographic character. And in each the problem of the water supply, essential in agricultural development, has to be solved as it comes up. It is simplest in Libya since there all that is necessary is the raising of water from the subterranean water table between the base of the plateau and the sea without allowing it to go to waste. To extend to the whole steppe zone the culture hitherto limited to the coastal gardens does not offer difficulties, provided capital is available. No great amount of capital is necessary, and it may be raised bit by bit as the area newly taken over for cultivation is extended. In Cyrenaica modest irrigation works would be possible such as are not unknown to the natives for utilizing the principal springs. In Somalia again the problem does not seem difficult, inasmuch as there is no lack of water to be derived from the great rivers; the solution, however, would need organization of works for providing irrigation on a large scale; wells could be used locally; and artesian water might be sought.

In Eritrea the problem is more complex. While on the plateau benefits proportionate to the effort could not be gained at moderate cost, in the valleys small dams could be easily built. On the marginal plains the solution would seem to be found in damming the mouth of each valley that is incised in the upland slopes and in regulating the dams in such a way that the water, after its use for irrigation, could again feed the subterranean water table rather than lose itself in the sea or farther out in the sandy plains of the Sudan.

FIG. 14—The Webi Shebeli at Afgoi, Somalia.

THE VALUE OF THE COLONIES

A colonial region can be viewed primarily according to its productivity in minerals and its agricultural value. Secondly, a colony represents for the mother country a region to which either its surplus inhabitants or its surplus industrial products may be sent or both together. The possibility of mineral development presupposes a particular constitution of the ground; other conditions more or less favor or interfere with exploitation but are not essential factors. Agricultural productivity is also governed by the nature of the soil but more particularly by the climate and the water supply. Settlement—and by this is meant settlement by white people—requires, in addition to agricultural productivity of some sort, special climatic conditions and also a sufficient capacity for population.

As regards possible mineral development it is known that the three Italian colonies do not offer great hopes. However, Eritrea should be distinguished from Somalia and Libya. The whole massive block constituting the Abyssinian plateau is of very considerable geologic age and has been subjected more intensely to the tectonic processes that lead to mineralization. Indeed, there exist on the Eritrean plateau numerous veins of gold-bearing quartz and various copper-bearing and iron-bearing outcrops which are well worth further

investigation. In the other two colonies, on the contrary, and in certain low hot zones in Eritrea (in Dancalia) the known mineral deposits are limited almost exclusively to superficial accumulations of salts favored by the hot and dry climate and the hydrographic conditions (closed basins of the coastal lagoons). However, search

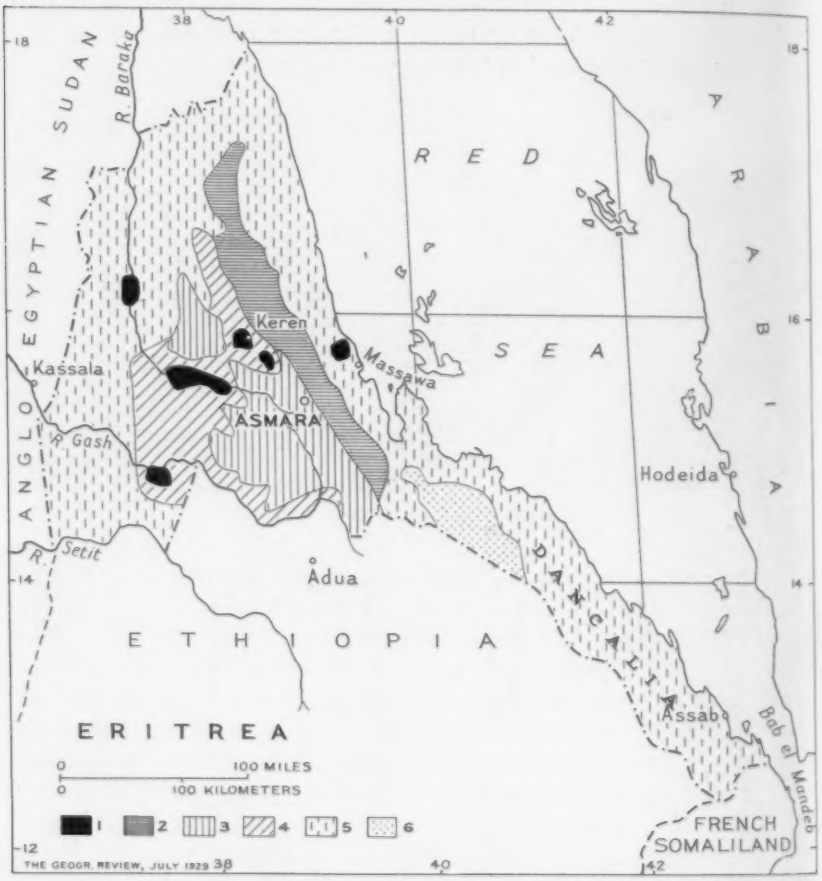

FIG. 15—Map of Eritrea. The numbers have reference: 1, principal areas under irrigated cultivation by settlers; 2, woods and pasture lands, durra cultivation, areas adapted to dry farming by settlers; 3, pasture land (with olive trees, juniper, and *Euphorbia candelabrum*), woods, and cereal cultivation on the plateau; 4, area of the interior valleys—acacia steppes, cultivable valley floors; 5, steppes and thorn forest in which acacias predominate; 6, desert. Scale approximately 1 : 6,000,000.

should be prosecuted for petroleum, certain indications of which have been noted near Massawa, for instance; and for phosphates, whose existence in Libya it is no longer possible to deny.

The economic development of our three colonies must be principally agricultural, though it cannot be everywhere equal. In Tripolitania, in the vicinity of the coast, intensive garden cultivation of an industrial plant, henna, prevails. For the rest there are tree

crops, fundamentally the date; with which are associated citrus fruits, the almond, pomegranate, carob, mulberry and, particularly in the least irrigated parts, the olive and non-arboreal crops, greens, potatoes, forage, and grains. In the neighboring steppe zone, which lies

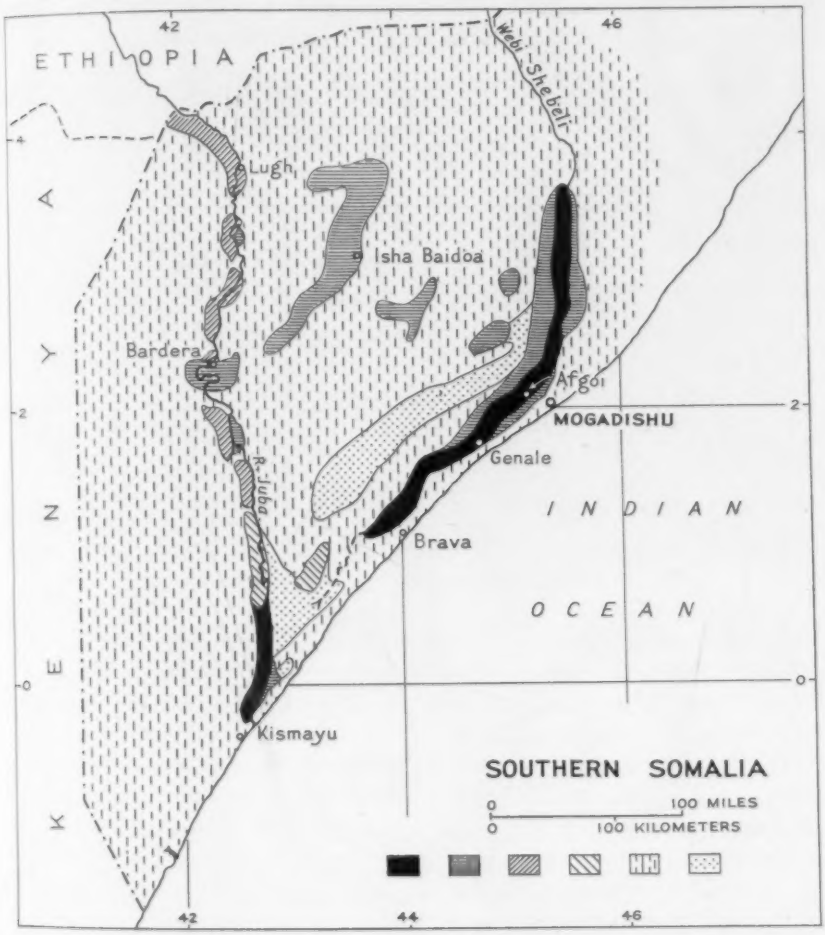

FIG. 16—Map of Southern Somalia. The solid black tint represents irrigated land for cultivation by settlers; horizontal ruling, durra cultivation; close diagonal ruling, gallery forest, for the most part palm groves; open diagonal ruling, gallery forest, for the most part sycamores and tamarinds; vertical ruling, woody steppes used in part for pasture; stipple, prevailing grassy steppe used for pasture.

Northern Somalia is not shown, for data are lacking. Steppes and thorn forests prevail, and there are local tracts of grassy steppe and lands in durra. Scale approximately 1 : 6,000,000.

between the coastal gardens and the foot of the plateau, barley and wheat alternate extensively with pasturage; and in the marginal zone and the plateau, within limited gardens and their orchards similar to those along the coast, there extends the great arboreal cultivation based on the olive and fig, with barley and wheat. What a difference there is—arising out of the special natural conditions already indicated

—in the character of the agriculture of Cyrenaica! Here, indeed, the cultivation of barley prevails: it is already exported in considerable quantities. Finally, Libya,—and we refer more especially to Tripolitania—alike through its climate and through its agricultural character, has many analogies with southern Italy, Sicily and Apulia in particular. It is not territory adapted to a typical commercial agri-

FIG. 17—A *bar*, isolated hill of crystalline rock, Somalia.

culture: but its garden and drier crop cultivations between the sea and the marginal fringe of the plateau may be extended.

White colonization would also be possible from the climatic point of view on the Eritrean plateau; but here there is already an agricultural population proud of its proprietary rights and endowed with a degree of civilization far from low. Cultivation, on the other hand, is not of an industrial nature. Any attempt to substitute on a large scale white agriculturists and white proprietors for the natives would be a serious mistake. But when one descends from the plateaus through the valleys carved out in the escarpment facing the coastal plains or the Sudan, one passes into a more typical tropical zone. And here we find also characteristic plants, many of which offer in their fruits or their fibers or their juices the raw material of industry. The same species besides many others, gums and aromatic plants, are found in the forests or in the scrub growths of Somalia. In Somalia as a whole and the lower zone of Eritrea colonial Italy guarantees the metropole an economic support neither insignificant nor meager. In addition to the climate necessary for the cultivation of industrial plants there is also the possibility of irrigation, most important of all for cotton. There have been attempts at exploitation which have proved unsuccessful, but they can be ignored: they failed because

they were not supported by adequate means or by the indispensable scientific and experimental preparation. It is sufficient to consider two undertakings in Somalia, to which reference has already been made, the government enterprise at Genale and that at Shidli due to His Royal Highness the Duke of the Abruzzi, to be convinced that a prosperous future may be looked forward to for both of these colonies

FIG. 18—Scene around a well, Somalia.

but particularly for Somalia. On the other hand, it is useless to cherish the illusion that there may be found between the Red Sea and the Indian Ocean an outlet for the superabundant population of Italy. These regions can support several hundreds or possibly thousands of whites but only in a supervisory capacity on the plantations.

Of the three colonies, Eritrea in the last analysis occupies a somewhat special place. This plateau is nothing more than an outlier of the immense Ethiopian plateau. And the latter, an independent political unit, densely inhabited by people of no inconsiderable civilization and of notable economic possibilities, is a potential outlet for Italian industries. A port and a railway connecting it with the plateau are already in existence: what is needed is the perfecting and extending of roads as lines of penetration.

Thus the three Italian colonies have aspects that differentiate them one from another. If the future of Somalia lies particularly in the development of industrial agriculture and that of Eritrea principally in its position as a commercial zone of transition towards the whole Ethiopian region and also towards Arabia, the importance of Libya remains principally political, assuring that equilibrium among the Mediterranean powers which Italy, the most Mediterranean of them all, has built up for safeguarding its own independence.

ANCIENT MEDITERRANEAN PLEASURE GARDENS

Ellen Churchill Semple

Noonday in early May on the Isthmus of Corinth. Beneath a ledge of gray limestone a ribbon of mauve shadow stretches across the narrow beach to a sapphire sea. A stiff breeze from the Hellespont tips the Aegean waves with curling crests, sucks up the moisture from the lucid air, and sends the limestone dust swirling down the white road. The sun burns face and hands as if its rays came through a lens, while the alkaline dust makes the eyes and skin smart. I creep for refuge into the purple shade beneath the ledge, blessing this "shadow of a great rock in a thirsty land," to eat my Homeric lunch of bread and wine, goat's cheese and figs.

CLIMATE goes far towards explaining those lovely pleasure gardens widely distributed in the ancient Mediterranean lands and still persisting in many places with their traditional features of confining wall or hedge, their seclusion and shade, their flower beds and ornamental fruit trees, their fountains and central pool, their sunken paths and marble seats and colonnades, their statuary and shrubbery, and the vine-grown pergola for the outdoor repast.

The Mediterranean climate encouraged the maintenance of pleasure parks and gardens, because the mild temperatures kept a succession of trees and plants in blossom all year round, brought winter blooms to the rose and almond tree even in northern Italy, and renewed the freshness of the evergreen foliage during the winter rains; hence it rewarded the labor of the cultivator and preserved the beauty of the garden in the cold season. But gardens were the boon of summer. The long, hot, cloudless months made the shelter of vine-grown arbor and cypress avenue a welcome refuge. When the thirsty etesian winds swept down from the north or the sirocco from Africa, only the garden kept moist and green and fresh. Eyes tired by a relentless sun and its reflection from the limestone roads rested gratefully upon the dark foliage of laurel or oleander. When the stifling afternoon passed and the people issued from their darkened houses, the garden paths invited to leisurely strolls. In the Paradise legend Adam and Eve heard "the voice of the Lord God walking in the garden in the cool of the day," after the custom of Palestine and other Mediterranean lands. Likewise Ammon Ra "walked abroad" in his temple garden at Thebes, where Queen Hatshipsut had planted myrrh trees imported from distant Punt.

But other factors, social and economic, contributed to the development of these ancient gardens: early concentration of population

in cities, expansion of trade and the accumulation of wealth, stimulation of civilization by commerce, growth of a cultured leisure class, with its concern for the amenities and luxuries of life. A more potent factor still was the rapid advance of agriculture till it attained the aesthetic stage, crowning evidence of its intensive character.

The cultivation of land for the mere embellishment of life is a frequent concomitant of intensive tillage, even when scant arable area makes such use of the soil seem extravagant. It is conspicuous in warm countries, where an open-air life is possible, but appears also in less exuberant form in colder countries that have a long growing season like England. As a native growth it meets us in modern Japan, the Hawaiian Islands, and other islands of the South Seas, in ancient Persia and Babylonia, in Kashmir and northern India under the Mongol rulers, and at the other side of the world in ancient Mexico. All these countries developed intensive agriculture, and all had to rely wholly or in part upon irrigation to secure an adequate food supply.

Ornamental gardening became a feature of ancient Mediterranean civilization. It began at the eastern end of the basin at an early period and advanced westward in the wake of trade and colonization. Everywhere it took root and became the fine efflorescence of that patient, tireless tillage of the region. It grew out of the widespread fruit, flower, and herb culture, which in greater or less degree depended upon summer irrigation. The pleasure gardens originated in walled orchards and vineyards, in plantations of flowering pomegranates, quinces, plums, and apricots, in groves of stately date palms, all with their irrigation pools and canals. The spaces between the rows of trees, for the more economic use of the precious soil, were often planted with flowers at once useful and beautiful, like the saffron-yielding crocus or the edible poppy, or "the henna flowers in the vineyards of Engedi," or the violets, iris, and roses of Boeotia, Cyrenaica, and other lands for the manufacture of perfumes and unguents.

The bloom and fragrance of the grape, pomegranate, and the nut tree were prized by the ancient Jews, as were the fruits. "I went down into the garden of nuts to see the fruits of the valley, and to see whether the vine flourished, and the pomegranates budded." Orchards and vineyards provided certain essential elements of the pleasure garden—blossoms, fragrance, and especially shade. Hence the ancient Mediterranean gardens, in their long development, employed vine-grown trellises, fruit trees, alleys of shade trees, and masses of shrubbery, and relied for artistic effects only in part upon flower beds. Even then they preferred the flowering shrubs, like myrtle, laurel, and oleander, masses of green picked out with pink or white. The aesthetic value of the ripe fruit was never discounted.

In point of size the ancient gardens varied from the ample palace grounds and parks of kings—which, however, reached only moderate

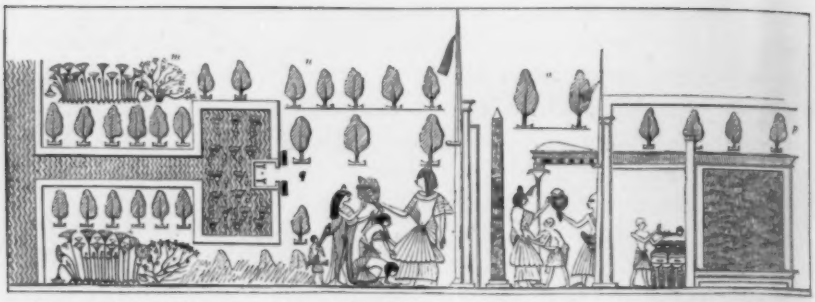

FIG. 1—Theban villa with garden. (After Wilkinson: The Manners and Customs of the Ancient Egyptians, 1847, Vol. 2, Fig. 116, p. 129.)

proportions as a rule—to the private garden, whose size depended on its location and on the means of the owner. In the size of gardens one seems to detect everywhere a certain restraint probably due to the high cost of land and of irrigation. Water theft from the public aqueducts was a common offense among Athenians and even the wealthy landed gentry of the Roman suburbs. The typical private garden was small, even diminutive. It lay near the house and formed an outdoor extension of it; here much of the family life was led. The master could step from drawing-room or dining room to flower-bordered terrace or shaded path. Resting on a marble bench or walking beneath a colonnade, he commanded a view of the whole. Its small size encouraged complete cultivation and ample use of water and did not necessarily lessen its beauty. A little garden dedicated to Eros is made to speak for itself in an anonymous Greek poem: "I am not great among gardens, but I am full of charm."

This small scale was yet further reduced in the exquisite miniature gardens planted in the peristyles of Greek and Roman houses in the century before the Christian era or perhaps earlier. The peristyle garden still survives in the Spanish patio with its arcade, central fountain, myrtles, pomegranates, jasmines, and palms growing in earthern jars. In the eastern Mediterranean it survives also in the spacious court of the typical Damascene residence, whose tessellated floor is broken in the center by water basin and fountain, surrounded by flowering plants. Orange, lemon, and pomegranate trees afford rest to the eyes. The fragrance of jasmine fills the air and penetrates to the recessed colonnade or *liwan*, where couches look out upon the enclosure.

In contrast to the small private gardens were the sacred groves and temple grounds. These also, like the peasant's orchard, felt the transforming touch of the gardener and became beautiful parks. The Temple of Jerusalem was an exception, because the Jews feared that trees in the courtyard might savor of the hilltop groves of Baal.

The summer drought dictated the introduction of water as an

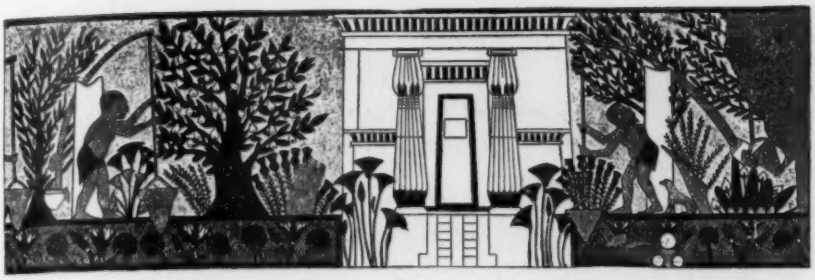

FIG. 2—The garden of Apoui, Thebes. (After Mémoires publiées par les membres de la Mission archeologique française au Caire, Vol. 5, 1894.)

unfailing feature of the garden. It was handled as an artistic motif in countless ways. It was conducted about in stone, cement, or tiled runlets; it emerged from some decorative opening in a terrace wall or issued in jets from a statue; it was collected in fishpond or lotus pool; it flowed from artificial grotto or leaped from a rocky ledge into a marble basin. Moreover, the irrigation canals with their secondary furrows necessitated a regular system, which tended to throw the garden plan into geometric forms. The modern oriental garden always seems dominated by the irrigation scheme on which its life depends. In the exquisite Indian gardens seen about Jaipur and Amritsar the water conduits dictate the basic lines of flower beds, tree plots, and pools, just as they do in the garden plans depicted on ancient Egyptian tombs.

The same thing is true of the Persian rose gardens which in Shiraz today reproduce the ancient garden pattern. An old description of a sixth-century Persian rug shows the design of a pleasure garden, planted in fruit trees and flowers, crossed by straight paths and irrigation conduits, while the border represents long flower beds. Persian garden rugs of 1600 and later show the traditional design—a central water basin with fish and ducks, canals leading thence in formal arrangement, narrow paths along the canals, cypress alleys or slender flower beds in the border, trees and shrubs growing in vases, while the weave in the streams resembles "watered ribbon."[1] The whole arrangement is rectilinear, reproducing the Persian garden plan as necessitated by irrigated horticulture in a semiarid land.

Like their Persian prototypes, the Mediterranean gardens were for the most part formal and architectural in style. They were not an idealized landscape like the English park, or a miniature landscape like the Japanese garden. They had no place for winding paths or pools with the sinuous outlines of natural shores. Back of the garden we see the engineer with his problems of hydraulic pressure, his

[1] See Marie Luise Gothein: Geschichte der Gartenkunst, Vol. 1, Jena, 1914, Fig. 102, p. 150. Volume 1 of this admirable work deals with the development of gardens from ancient Egypt to the Renaissance in Italy, Spain, and Portugal and is richly illustrated. An English edition of the work is now available, New York, 1929.

traditions of durable and economical construction, even when pursuing aims of beauty, and his architectural skill in utilizing the small space at his command.

So much for the general conclusions. A survey of the ancient Mediterranean gardens according to countries will demonstrate the truth of these conclusions and show the types that developed in various regions, owing to local differences of geographic, economic, and social conditions.

FIG. 3—A Persian garden. (From an early sixteenth-century miniature in the Cochran Collection, Metropolitan Museum of Art, New York.)

Paradise, that garden which "the Lord God planted eastward in Eden," was modeled upon the gardens found in all irrigated lands from Persia to Palestine; and it became a prototype of the flowery retreats of Mediterranean civilization from Damascus, Jerusalem, and Antioch in the East to Spain and Granada in the West. The river that watered Paradise was divided into several channels, after the manner of "the shorn and parcelled Oxus," the Nile, and other irrigation streams. The garden contained "every tree that is pleasant to the sight, and good for food." The tree of knowledge and the tree of life were rare exotics introduced by the early dramatist who staged here the first great tragedy of man.

The desert Arabs, who skirted the high rim of the Mediterranean Basin from Moab to Hermon and looked down on the irrigated gardens of Damascus and Ramoth-Gilead, pictured their paradise as a pleasure garden abounding in fountains of pure water. There in the noonday heat the saints reclined on silken couches spread in deep shade and enjoyed the fruits always ripe on the trees. It was the Garden of Resort in the Koran, the Garden of Eden, the Garden of the Most High with everything to satisfy the taste and delight the eye. "Close down upon them shall be its shadows and lowered over them its fruits to cull." Though the Arab paradise waited for the pen of Mohammed, it belonged of old to the Semites of desert and grassland; it doubtless lived in Arab poetry, ages before the seer of Mecca.

Gardens in Palestine and Syria

The oriental models found apt imitators in Palestine, Philistia, Phoenicia, and northern Syria, where geographic conditions encouraged their introduction and further development and where the rich and powerful maintained large estates; but the Judean peasant enjoyed his leisure beneath his own vine and fig tree or raised a few flowers in his herb garden. King Solomon had his pleasure park near Jerusalem, whither he was wont to go in the morning, Josephus tells us. It was laid out in fine gardens and abounded in rivulets. The author of the Song of Solomon described an ideal garden to which he compared his beloved. A high wall ensured its privacy, and it was watered by a never-failing spring. Almond trees raised their crowns of pale pink blossoms. The scarlet fruit of the pomegranate trees punctured the dark foliage with points of light. There were beds of narcissus, crocus, henna, and all the other aromatic plants that could be made to grow, while the blossoming grapevines gave forth their perfume. "Awake, O north wind; and come, thou south; blow upon my garden that the spices thereof may flow out."

Fig. 4—A Persian garden. (From an early sixteenth-century miniature in the Cochran Collection, Metropolitan Museum of Art, New York.)

The Bible in figurative language indicates the beauty of these gardens, specifies their trees and flowers, and suggests their wide prevalence. The Garden of Eden is the synonym for earthly beauty and productivity. Jehovah, placated after one of the habitual backslidings of His people, promises to convert the desert into a tree garden: "I will plant in the wilderness the cedar, the shittah tree [acacia], and the myrtle, and the oil tree; I will set in the desert the fir tree, and the pine, and the box tree together."

In the Book of Ecclesiasticus, Wisdom compares her glory to the beauties of a garden—to the cedar of Lebanon, to the cypress of Mt. Hermon, to the palm and the olive and the plane, to the wide-spreading terebinth tree, to the blossoming grapevine, and the roses of Jericho.

From her issue pleasant odors like the fragrance of spices and sweet-scented shrubs. She invites all to come and eat of her fruits. Then the figure of speech shifts to another feature of the garden: "I also came out as a stream from a river, and as a conduit into a garden. I said, I will water my garden, and will water abundantly my garden bed; and, lo, my stream became a river, and my river became a sea." So full flow the wellsprings of wisdom.

In the city of Jerusalem the royal rose garden alone was allowed, because no dung might be brought within the walls; outside, practical considerations probably dominated, though the introduction from Greece of laurel, iris, ivy, mint, narcissus, box, and rue indicates an aesthetic motive. Under Greek and Roman rule, when peace brought plenty, the environs of Jerusalem blossomed with gardens, orchards, and olive groves. A wide stretch of these north of the Wall of Agrippa was destroyed by Titus in 71 A. D. during the siege of the city. On this side opened the Gate of Gennat or Garden Gate. East of Jerusalem, on the Mount of Olives, lay the Garden of Gethsemane, much frequented by the citizens. When the April sun ripened the fields of barley and the first blast of the sirocco heralded the Feast of the Passover, thither the men of Jerusalem, escaping from the city's heat, would resort for nightly promenade. One such group of friends, one such night, made this little pleasure park a synonym of agony. Another such garden near the hill of Golgotha received the body of the dead Christ. The ancient Jews used these green enclosures as family burying grounds, in which a natural or artificial cave served for the sepulcher.

Semitic garden technique was early perfected in Syria, because this land, more than Palestine, was constantly subjected to Persian influences, both through trade and conquest. There the imperial rulers established royal parks, where the cedars of Lebanon grew larger and finer than on their native mountains. The palace of the Persian governor of Northern Syria, at the source of the little Dardes River between Aleppo and the Euphrates, had a "beautiful garden containing all that the seasons produce," but it was destroyed by Cyrus the Younger in 401 B. C.

Throughout Syria and Palestine the groves on hilltops, consecrated by the native Semitic population to the worship of Baal and the generative forces of nature, seem to have been improved by cultivation. These groves were sometimes found growing about high-laid springs, which later were distributed into water conduits, or they were planted as acts of devotion near a spring or well. The sacred trees were the oak, tamarisk, poplar, palm, and terebinth, all which were improved or maintained by irrigation. As the groves were gradually provided with altars and finally with temples they became converted into gardens.

The native Canaanites and Phoenicians dedicated these gardens with obscene rites, but the Israelites also frequented them and thereby provoked the denunciations of the prophets. Such probably was the sacred grove and temple of Astarte, located at the springs of the Adonis River (Nahr Ibrahim) below the crest of the Lebanon Mountains. Here the people of Byblus and neighboring Phoenician cities

FIG. 5—The Garden of Gethsemane. (Photograph by James Ricalton, courtesy *of American Forests and Forest Life.*)

celebrated every spring the death and resurrection of the nature god Adonis, youthful lover of Astarte (Aphrodite). Here the red anemone, dyed in the blood of the slain god, bloomed amid the cedars and walnut trees. and here the mourning worshippers sacrificed the miniature "gardens of Adonis," which figured in his rites as practiced in western Asia, Alexandria, and Greece. They were small baskets or earthern pots planted with wheat, barley, fennel, lettuce, and various flowers; epitomes of field and garden, sprouting and withering in eight days, they typified the ephemeral life of spring vegetation. Adonis worship prevailed also in contaminated Jerusalem, where Ezekiel saw the women wailing for the god in the temple gate. Isaiah describes the short-lived gardens which were placed before the images of Adonis, exactly as one sees them today in the Catholic churches of Italy on Good Friday, the vernal memorial of the dead Christ.

The Phoenicians were commercial nurserymen in Homeric times. Their cargoes included plants and trees, useful and ornamental, which were disseminated over the whole Mediterranean from their native habitats in the East and early became commodities of general international trade. This process stimulated horticulture, spread informa-

tion as to methods of cultivation, or led to large-scale experiments in acclimatization. It is possible to follow the introduction of the peach from Persia into Egypt, thence into Rhodes where the tree long sulked and refused to bear, and finally into Greece and Rome.

Egyptian Gardens

Phoenicia and Palestine, through centuries of commercial and political affiliation with Egypt, drew suggestions for their horticulture

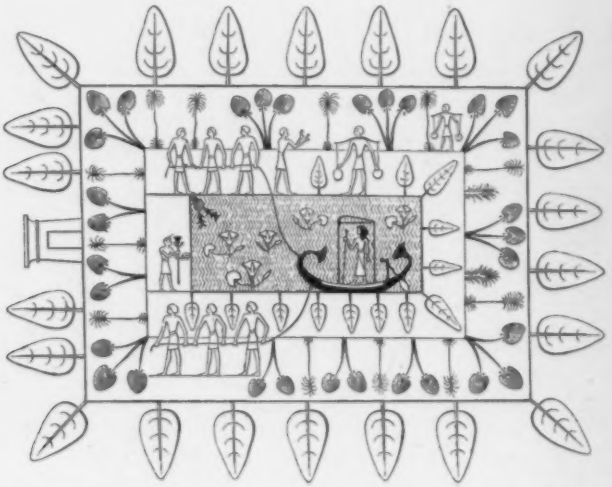

Fig. 6—Painting on a tomb at Thebes. (After Wilkinson: A Popular Account of the Ancient Egyptians, 1871, Vol. 1, Fig. 27, p. 25.)

also from the Nile Valley. There all conditions encouraged the early development of pleasure gardens—careful agriculture, a long, hot summer and the need of escape from it, demand for flowers in the worship of nature gods like Isis and Osiris, and finally the presence of a rich and refined leisure class. The Egyptian pleasure garden never lost the marks of its origin in orchard and vineyard and of its conformity to the requirements of irrigation.

Formal gardens existed in Egypt in the Fourth Dynasty (2800 B. C.). In the Eighteenth Dynasty garden technique was fully developed and beautified the country and city houses of the wealthy. Local plant resources no longer sufficed; incense trees and other exotics were imported. A garden of this period, depicted at Thebes, shows a walled enclosure laid out in eight sections. The middle section is occupied by a long grape arbor shading a path to the dwelling. Near by are two water basins with pavilions on their margins, lotus flowers floating on their surface, and ducks swimming about. Two other rectangular tanks, bordered by avenues of alternate palms and fig

trees, occupy the front part of the garden. An artistic balance marks the composition of the whole.

A picture in a high priest's tomb at Tel-el-Amarna shows a complex of buildings, comprising his residence and the storehouses of the temple,

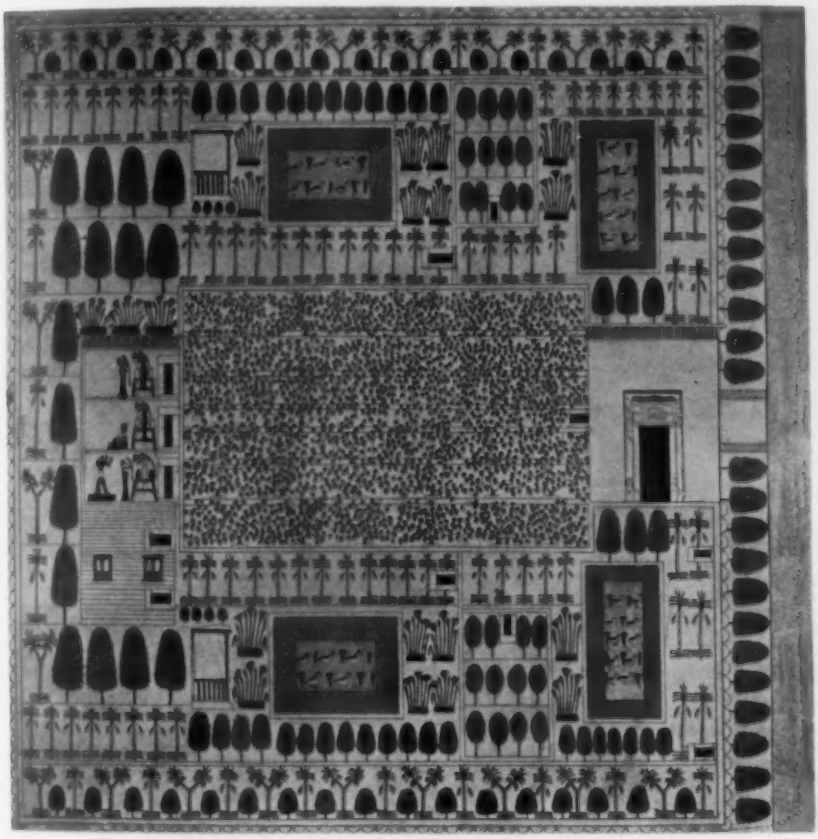

FIG. 7—Painting in a tomb representing the garden of the commander in chief of Amenophis III, Thebes. (After Ippolito Rosellini: I Monumenti dell' Egitto e della Nubia, Monumenti civili, Vol. 2, Pisa, 1834.)

all surrounded by a garden. Trees set in depressions to hold water fill the spaces between the buildings. A palm garden has a square tank or pool in the center, around which other trees are planted in formal lines. A flight of steps leads down to the water, while a kiosk overlooks the pool. This is a recurrent feature in Egyptian gardens. A villa garden depicted on another Theban tomb has the usual combination of canal, water basin, shady avenues, and flower beds but in addition shows an awning stretched over the entrance of the dwelling and projecting into the garden to form an outdoor room.

Flowers were used profusely in the social and religious life of the

ancient Egyptians. At banquets they decked both table and guests. The guests wore lotus buds in their hair and held out the open blossoms to one another to smell. Garlands festooned the wine jars. Bouquets were offered to the gods; wreaths encircled the necks of sacrificial geese and bulls and covered the mummy cases on their way to the tomb. Finally, according to a love song of the Turin papyrus, a garden is the trysting place of two lovers; and there beneath a wild fig tree they meet "on the festival of the garden." One is reminded inevitably of Japan with its national flower festivals and its passion for gardens.

Greek Gardens

In contrast to the explicit testimony on aesthetic gardens left by Egyptian tombs and papyri, evidence of development of private gardens in Greece is fragmentary and meager till Hellenic culture has passed its zenith: then the references become abundant. The pseudo-Platonic dialogue "Minos" alludes to authoritative books on gardening which have vanished. But there is ample evidence of a highly developed garden technique, which beautified the temple groves with flower beds and fountains and converted prosaic orchards into recreation parks.

The Greeks, like the Hebrews, show a love of gardens in their mythology. As companion piece to the Garden of Eden, they give us the Garden of Hesperides, located in a fabled island of the far west. Pindar describes its beauty:

> There round the Islands of the Blest,
> The Ocean breezes blow,
> And golden flowers are glowing,
> Some on trees of splendor growing
> And some the water feedeth.
> Fair wreaths they yield, wherewith
> The happy ones do twine their hands.

The garden of Alcinous, though planted for practical purposes, reveals a sense of horticultural beauty. "Without the courtyard hard by the door is a large garden covering four acres; around it runs a hedge on either side. Here grow tall thrifty trees—pears, pomegranates, apples with shining fruit, sweet figs, and thrifty olives. On them fruit never fails; it is not gone in winter or in summer but lasts throughout the year. And here trim garden beds, along the outer line, spring up in every kind, and all the year are gay. Near by two fountains rise, one scattering its streams throughout the garden, one bounding by another course beneath the courtyard gate toward the high house."

From such farm gardens developed the Greek pleasure garden. Flowers were raised on all country estates to provide "decorations for altars and statues and wreaths of beauty and fragrance for the person." They were the chief crop in industrial gardens, which sup-

plied the maker of perfumes and unguents. Those in Cyrenaica were famous because the semiarid climate made the roses, violets, and crocuses more fragrant than elsewhere. Such commercial nurseries doubtless stimulated aesthetic horticulture, which was also aided by Alexander's conquest of western Asia; for the victors returned with new fruits like the citron, with new plants, and with countless Semitic

FIG. 8—Mural painting in the palace of Cnossus representing boy gathering crocuses or saffron for a religious ceremony or feast. About 1800 B. C. The original is in the museum at Candia. A reproduction in color appears in Sir Arthur Evans's "The Palace of Minos," Vol. 1, 1921. (This reproduction is from Plate 26 of Rostovtzeff: A History of the Ancient World, Vol. 1: The Orient and Greece, 1926, by permission from the Oxford University Press.)

slaves trained in garden technique; finally they were filled with enthusiasm for the numerous Persian paradises they had seen.

But Greek gardens had appeared in Athens before this. Aristophanes mentions "fragrant gardens" injured by insects; vine-grown gardens where the birds picked the berries of the myrtle, poppy, and sesame; and sweet violets growing by a fountain in a garden. Such allusions are short and casual, but they indicate quiet green retreats like that Lesbian Garden of the Nymphs described by Sappho (600 B. C.):

> Through orchard plots with fragrance crowned
> The clear cool fountain murmuring flows,
> And forest trees with rustling sound
> Invite to soft repose.

We hear more of private gardens which were thrown open to the public and therefore figured in the common life. Cimon of Athens, general during the Persian War, pulled down the walls of his garden and grounds in order that his fellow citizens might share the fruit. Plato, Epicurus, and Theophrastus bought land and planted gardens

to be used for schools of philosophy, and they came to rank among the glories of Athens.

The architecture of the Greek dwelling, with its open peristyle court, suggested the interior garden as a natural accessory; yet in Homeric times and long afterward this court served as an outdoor workshop. Where or when it first came to be planted and beautified is unknown; for this evanescent art of flower and shrub would leave few traces. Yet the remains at Herculaneum and Pompeii reveal the perfect development of the peristyle garden in Greco-Roman houses of the first and second centuries before the Christian era. Vitruvius describes the Greek drawing-room in the Cyzicene style of house as facing north upon gardens in the rear and having windows like folding doors, so that the garden view might be unobstructed. To this and later periods belonged the perfected house garden of the widespread Greek cities. These were small and exquisite, rigidly symmetrical, and adorned with colonnades and statuary. Shade trees and fountains cooled the air; beds were planted each with a separate kind of flower, lily or rose, violet or crocus, lest the large should rob the small of its nourishment. Gardens by the sea had lagoons and navigable channels, in which grew marine plants, encircled by native trees and shrubbery.

It was in their public parks, however, that the democratic Greeks developed their national talent for landscape gardening. These grew out of the sacred groves, transformed by every means of enhancing natural beauty known to the Greeks, and devoted to popular recreation and exercise. The Academy of Athens, outgrowth of Athene's sacred olive grove in the Cephisus Valley, was repeatedly beautified by tyrants and statesmen of the city. Hipparchus surrounded it with walls in the late sixth century before Christ, and Cimon embellished it with walks, trees, and fountains. Here were alleys of elm and plane, "sunless at noon," nightingales singing in the deep coverts, groves of laurel and olive, narcissus and crocus blooming abundantly beside the irrigation rivulets. Thus Sophocles knew it, as later did Plato and his followers. Gymnasia and palestrae were places not only of training but also of recreation; and their plantations of trees, shaded walks, and fountains attracted young and old. The ground plans of gymnasia excavated at Delphi, Priene, Epidaurus, and Pergamum indicate that landscape gardens occupied the peristyle enclosures. Even prosaic Sparta located its wrestling ground in the Plane-Tree Grove on an island in the Eurotas River.

The sacred groves of forest trees, which antedated temples, were gradually improved by cultivation, diversified by ornamental trees and plants, and adorned with marble altars and fountains; for springs were invariably present, whose nymphs were honored. Fruit trees contributed their beauty and yielded revenue. Strabo says that "flowery groves" surrounded the temples to Artemis, Aphrodite, and the nymphs

in the Alpheus Valley about Olympia. Here Xenophon built a temple to Artemis in an orchard. Pindar speaks of the "pleasant garden" surrounding Aphrodite's temple in Cyrene, where the Greek colonists maintained consecrated groves. Finest of all was the Garden of Daphne, sacred to Apollo, near the city of Antioch. It was famous for its laurel and cypress trees, its fountains and streams, and its shining temple of Apollo, whose sumptuous festival was held every August.

A motive for the introduction of flower gardens into the sacred groves lay in the demand for a particular flower in the cult of each deity. Aphrodite was the "violet-crowned" protector of blooming gardens. Sacred to her also were the rose and the bridal myrtle with its fragrant white blossoms. The laurel tree with its clustered bloom, essential in the worship of Apollo, was always planted near his temples. Laurel and myrtle were not native to the Crimean shores of the Euxine; the Greek colonists there tried by every known art to grow them for religious purposes, but in vain. They succeeded in raising figs and pomegranates, whose foliage and fruit graced many a Mediterranean garden, but had to cover the trees in winter.

Greek settlers on distant Mediterranean shores were constantly reclaiming some new spot to beauty. Colonists on the Asia Minor and Syrian coast were doubtless stimulated thereto by contact with the Persians. Tissaphernes, Persian satrap of Lydia during the Peloponnesian War, had a park, "a place charmingly wooded and watered, with delightful walks and summerhouses." Antioch was laid out by Seleucus Nicator on a magnificent scale with boulevards planted in flower gardens, which were bordered by colonnades and ornamented with marble pavilions, baths, and fountains. From the west gate of the city an avenue led through a suburb of garden-set villas, vineyards, rose gardens, and groves to the Park of Daphne. The Ptolemies laid out a succession of fine public gardens in Alexandria about the museum and gymnasium; the latter had porticos six hundred feet long enclosing a shady court.

The social conditions of Hellenic Syria and Egypt, which assured wealth to the ruling class, recurred among the colonial Greeks of Sicily and there too resulted in a display of gardens. Gelon, tyrant of Syracuse (476 B. C.), had a royal park of great beauty. It was well irrigated and contained a wonderful "Horn of Amaltheia," a plot of blossoming fruit trees and flower beds, accounted a masterpiece of the gardener's art. Hiero II of Syracuse achieved the fantastic in horticultural art. On the upper deck of a monster pleasure ship he laid out a roof garden, which was provided with walks, pergolas, and arbors covered with ivy and grapevines; shrubs and flowers were planted in casks of earth to complete the effect.

The use of flowers runs through all Greek life. Every dwelling

seems to be in touch with some garden. The people have the tender feeling for flowers that characterizes one who has cultivated his own garden. In all their public celebrations and in their common daily life the Greeks made an extraordinary demand for flowers, which expert florists supplied all the year round. There was a regular succession of blooms, from the white violet of mild days in winter and the early plum to the autumn flowers which, when planted in sunny and protected spots, prolonged their season far into the winter.

"Violet-wreathed Athens" had daily flower markets where many

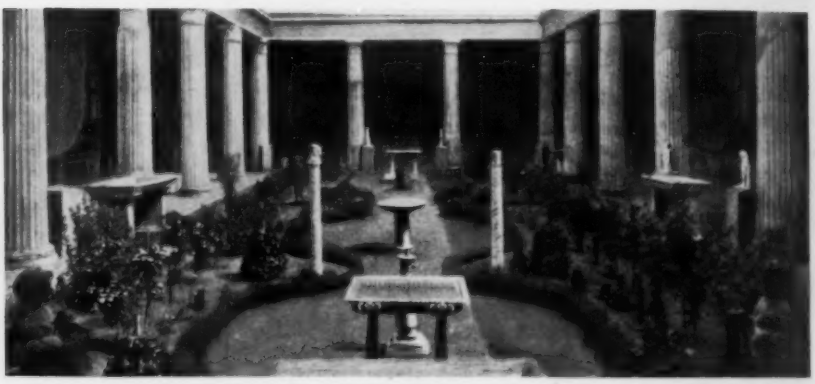

FIG. 9—Restoration of the peristyle garden in the House of the Vettii, Pompeii.

varieties of roses and violets were sold, besides phlox, hyacinths, narcissus, iris, lychnis, myrtle, lilies, anemones, crocuses, and numerous sweet-smelling shrubs. Flower girls went from house to house, offering their wares for sale or filling a regular order as if they were delivering milk and eggs. Flowers were cultivated in market gardens in the suburbs. Roses received special attention. The bushes were transplanted frequently and were cut back to prevent deterioration of the bloom; or they were burnt back—a treatment known to some modern European florists.

The Greeks constantly varied the native supply of garland flowers by foreign importations and domestication of wild species. They knew which countries produced the finest and most fragrant varieties, but they experienced difficulty in growing these in an alien climate and soil. Domestication presented similar problems. A species of wild thyme was transplanted from the mountains and cultivated at Athens and Sicyon; but as wood plants were often sterile under domestication, considerable art was required to propagate them. A remarkable hundred-leaved rose was grown at Philippi in eastern Macedonia. It had been domesticated from a many-leaved variety which grew wild on the slopes of Mt. Pangaeus near by. As this coast had been the scene of early Phoenician settlement from the neighboring

island of Thasos, one surmises that this rose of the Macedonian hills was perhaps an exile from some far Sidonian garden. Or it may have been derived from the garden attributed to Midas by Herodotus, "in which wild roses grow, each one having sixty petals, and surpassing all others in fragrance."

Roman Gardens

The practical Romans, for centuries a race of farmers, reveal the slow evolution of aesthetic horticulture from the merely economic;

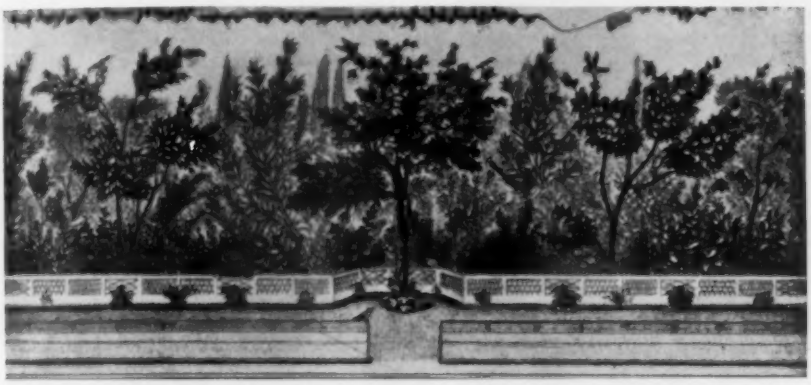

Fig. 10—Restoration of a garden fresco in the House of Livia before the Porta Prima of Rome. (Antike Denkmäler, Vol. 1, Berlin, 1891, Pl. 24.)

eventually they gave it the final touch of beauty and magnificence. In ancient Latium, as in Greece, the garden was part of every farm. Primarily for fruits and vegetables, it included also flowers for the garlands used in ceremonies. An ancient scene reported by Roman tradition is that of Tarquinius Superbus (534 B. C.) in his garden showing a perturbed official how to handle a threatened revolt, by silently striking off the heads of the tallest poppies as he sauntered down a path. Cato the Elder (d. 149 B. C.) states that every farm garden should contain flower beds and ornamental trees, like the nuptial myrtle, the Delphic and Cyprian laurel, and that it should be laid out near the house.

Two centuries later Columella, in his "Carmen Hortorum," describes the garden of a large estate, emphasizing the flowers, which he calls "those earthly stars . . . the violet beds unfold their winking eyes . . . the rose abashed with modest blush unveils her virgin cheek," "the horned poppies with their wholesome fruit and poppies which fast bind eluding sleep," "plants of a thousand colors." This is a farm garden. Its flowers, along with vegetables and fruits, are packed into white osier baskets and sold in the nearest market town. The flower trade pays, for "the vendor, with staggering

pace and soaked with wine, joyfully from town returns, weighed down with cash."

The demand for flowers increased with increasing luxury in the late republic and the empire. In early times public benefactors were honored by simple chaplets of leaves; later, crowns of blossoms became customary. From Rome's early days garlands decorated the temples of the gods, the domestic Lares, and the sepulchers; but later in private life their use increased. At banquets roses were scattered on the tables and crowned the guests. "Let not roses fail the feast, nor lasting parsley, nor the lily soon to die."

FIG. 11—The Mausoleum of Augustus turned into a garden. (After Lanciani: The Ruins and Excavations of Ancient Rome, 1897, Fig. 182, p. 463; courtesy of Houghton Mifflin Company.)

Horace states that in his time flower gardens had become a great national indulgence, displacing field crops. The territorial expansion of imperial Rome caused an economic reaction upon production in Italy, a reaction that was strong and immediate, owing to easy maritime communication between Rome and remote parts of her empire. The importation of provincial grain into Italy discouraged agriculture and interrupted the normal evolution of tillage. But a partial readjustment followed when Roman farmers concentrated on intensive garden and fruit culture and thus specialized in products that were proof against foreign competition. The change stimulated the finer aspects of horticulture, while increasing population and wealth multiplied the demand for the rarer products, whether flower, fruit, or vegetable. Thus an improved floriculture constantly enlarged the element of beauty in the Roman kitchen garden.

Furthermore, increasing contact with Greeks and Asiatics, who already had a highly developed horticulture, and the growing wealth of the patrician and equestrian orders at Rome combined to make the pleasure garden the fashion in Italy. Riches and slaves poured into the country from the eastern provinces. A force of expert workmen was at hand just when a cultured capitalistic class at Rome was looking for new and refined enjoyments and when the wear and tear of city life and the excitement of political campaigns drove the wealthy to provide rural retreats for themselves. They began to convert old

farms into country estates with shady groves, formal garden, and summer dining room in marble pavilion. Or they built smaller suburban villas, each with its pleasure garden, like that of Diomedes near Pompeii and of the Younger Pliny at Laurentum. The millionaires laid out their gardens in the city and there, within enclosing walls,

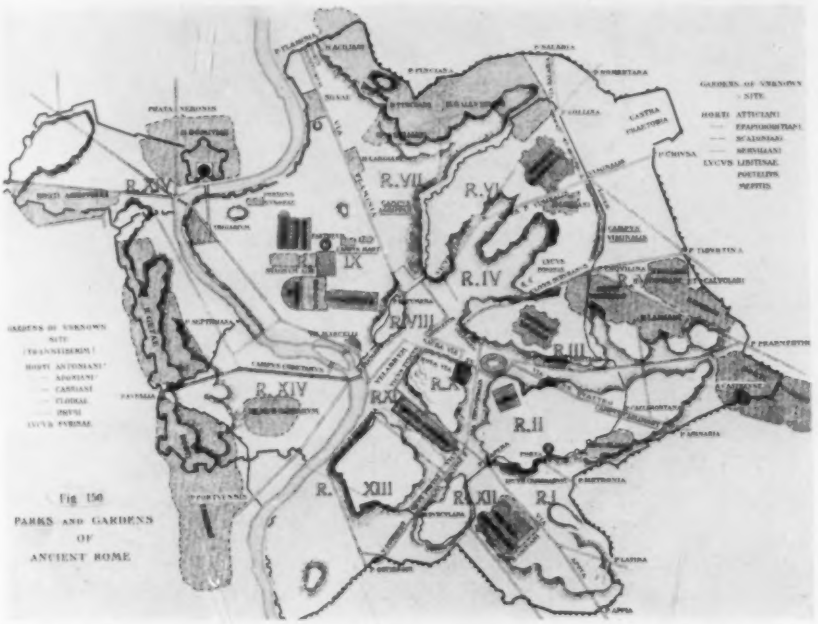

FIG. 12—The parks and gardens of ancient Rome. (Reproduced from Lanciani: The Ruins and Excavations of Ancient Rome, 1897, Fig. 150, p. 394; courtesy of Houghton Mifflin Company.)

made their green retreats. The building of villas became a passion among the Romans. Cicero, in addition to his ancestral estate at Arpinum, bought seventeen others which he improved and occupied from time to time. Lucretius, writing in 61 B. C., pictures the restless high-class society of his day vibrating between town and country house.

Private pleasure gardens therefore abounded within and without the capital. A map of imperial Rome shows them extending over the hills for two miles or more on both sides of the Tiber, almost encircling the city with a wreath of green. The significant fact of their distribution is their paucity within the old city of the Seven Hills enclosed by the Servian walls and their great number and expanse immediately outside them. The inner city, even in imperial times, contained only the garden of Lollia and part of the garden of Maecenas.

The outer girdle of green comprised the Pincian Hill, the ancient *collis hortorum*, where lay the gardens of the Acilian family and Pompey, the sumptuous gardens of Lucullus which later became the

haunt of Messalina, and the beautiful grounds of the historian Sallust, which in the Italian Renaissance became the site of the famous Villa Ludovisi. The green belt curved east and south through a long series of gardens, most famous of which were the *Horti Maecenatis*. These were laid out above an old potter's field and dumping ground of the Esquiline Hill, which Maecenas covered with twenty feet of earth and converted from a plague spot into a place of beauty. The low plain west of the Tiber and the slopes of the Janiculum and Vatican Hills were covered with imperial gardens. Lanciani estimates that the capital under the Caesars had one-eighth of its area laid out in gardens and therefore was provided with lungs as are few modern cities.

We have scant data as to the size of the gardens. Those of the emperors and nobles were undoubtedly large, like that of Maecenas, which measured about 1000 by 300 feet, some seven acres. However, this area included the palace and various other buildings which constituted a rich establishment; so that the planted spaces were probably small. The ruins of the imperial palace on the Palatine Hill contain traces of a formal garden two acres in extent, measuring 525 by 156 feet. These gardens were large, considering their location within the city; but one represented wealth, and the other imperial power.

The famous porticoes and gardens of the Campus Martius presented a total length of over three miles of covered walk and sheltered an area of about six acres; but they enclosed garden spaces amounting to sixteen acres. The *Porticus Liviae*, which Augustus laid out as a public garden on the Esquiline Hill, has left remains sufficient to indicate its size and character. It was a sunken parterre two acres in extent (377 by 246 feet), approached by a flight of steps from above and surrounded by a double colonnade which overlooked the central garden space. This isolated *Porticus* was probably typical of those in the Campus Martius and suggests a taste for small and finished garden plots even as public parks.

Outside the city the gardens were large wherever wealth abounded. Magnificent villas with beautiful grounds were distributed along the main highroads within easy chariot ride of the capital. They occupied all the choice sites in the Alban Mountains, an old volcanic region of fertile soil, deep woods, lakes and springs, fifteen miles southeast of Rome. High up on the northern slope, above modern Frascati, Cicero had his Tusculum villa with gardens laid out in terraces and shady groves, one of which he called the Academy and another the Lyceum. Near by Lucullus had one of his sumptuous estates, with formal walks, open pavilions, and outlook towers.

The Sabine Mountains on the western flank of the Apennines had many villas about Tibur (Tivoli), notably those of Maecenas, Augustus, and Hadrian. The seashore also had its country estates, not only Ostia and Laurentum, which were within easy reach of Rome, but

also remoter points like Antium and the beautiful region about the Bay of Naples. When the Italian Renaissance revived the ancient type of gardens, many estates like the Villa d'Este at Tivoli, the Villa Aldobrandini at Frascati, and the Villa Barberini at Rome occupied the sites of the once famous gardens of Hadrian, Lucullus, and Nero.

FIG. 13—Woman in a garden: mosaic in the Baths of Pompeianus. (After Charles Tissot: Géographie comparée de la Province Romaine d'Afrique, Paris, 1884, Vol. 1, Pl. 3.)

Moreover, they utilized ancient statues and vases which came to light when the soil was dug up for the new plantations.

The detailed description left by the Younger Pliny of his suburban villa at Laurentum and his country estate in Tuscany reveal the leading features of ancient Roman pleasure gardens. Like the Egyptian and Greek gardens, these were formal in design and were connected with the dwelling, so that life indoors and out was not divorced. The typical villa had a long portico opening upon a terrace. This was the *xystus* of the garden and served as an open-air drawing-room. Its level surface was covered with turf, broken here and there by beds of violets, crocuses, lilies, or other low flowers, each kind by itself in a separate plot. Its outer edge was bordered by box or other shrubs, trimmed often in fantastic shapes as in Pliny's Tuscan garden, or by a low marble balustrade recessed at intervals to hold a tall marble vase or fountain basin, as depicted in the wall paintings in the Palace of Livia at Prima Porta and the garden frescoes of Pompeii.

The *xystus* overlooked a lower garden, or *ambulatio*, with which it was connected by broad steps or a grassy ramp. Seen from above, the *ambulatio* presented the appearance of a varied mass of foliage grateful to the eye. But the shining green of the pomegranate trees

was pricked by the nasturtium red of its fruit. The pure yellow of the citron and the pale buff of the quince stood out against the dense green behind; for these fruits served the same decorative purpose as the lemon and orange later in the Renaissance gardens of Italy and

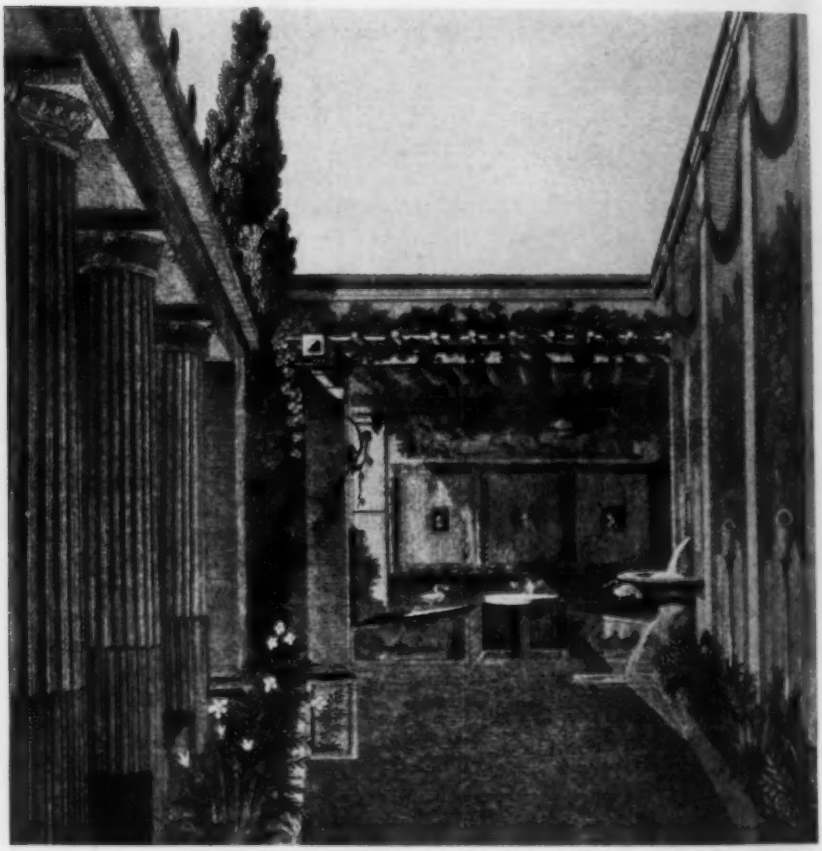

FIG. 14—Garden of the House of Sallust, Pompeii. (After François Mazois: Les ruines de Pompéi, Paris, 1824, Pt. 2, Pl. 38.)

the Moorish gardens of Spain. They contrasted with the solid masses of the flowering laurel and the pink or white oleander bushes, and their rounded tops of green with the slender spires of the cypresses.

This *ambulatio*, or second part of the typical Roman garden, was planned for leisurely strolls after a meal when mild exercise was joined to conversation. It consisted, therefore, of shaded walks and alleys for use when the sun was hot and of open paths for twilight hours. The spaces between the walks were planted with fruit or shade trees; but where a vista opened to sea or mountains the eye ranged across low beds of hyacinths, asters, jasmine, and roses.

The third section of the Roman garden was the *gestatio*, the shaded avenue where the master took his airing on horseback or in a litter carried by slaves. It either encircled the *ambulatio* or was laid out quite apart, usually in oval form. In either case it was bordered by a fancifully cut box hedge or by dwarf plane trees; for the Romans had discovered the art of dwarfing trees by peculiar methods of plant-

FIG. 15—Patio of the Linderaja, the Alhambra.

ing and topping them. The topiary art of clipping trees and shrubs was introduced into Rome from Syria about the beginning of the Christian era.

Gardens were not the monopoly of the rich and noble in ancient Italy. The remains of Pompeii show them attached to the average town residence scaled down to the size of a town lot. The old Italic *atrium* house of Pompeii had a small garden in the rear, enclosed by extended side walls of the dwelling and a cross wall at the back. It was therefore as wide as the house but usually quite shallow. The House of Sallust, built in this old style in the second century before Christ, had such a garden, 60 feet long and only 20 feet wide. Though small, it had all the elements of the traditional garden.

Pompeii lay in a region of ancient Greek colonies and had a considerable Greek element in its population, as indicated by numerous family names. Hence the Greco-Roman peristyle type was established here in the second century before Christ and prevailed in the handsomer dwellings. The peristyle court was adorned with flower beds.

vases of growing plants, fountains, water basins, and statues. All were arranged with studied symmetry, as the traveler sees them today in the great peristyle (33 by 65 feet) of the House of the Vettii, which has been restored and replanted according to the original plan.

Behind the peristyle and its apartments usually lay the garden or *viridarium*. The portico façade thrust out wings at either end and enclosed the garden on three sides by colonnades. A Pompeian wall painting depicts this type of semi-inclosed garden, evidently borrowed from Greece as it resembles the Cyzicene house garden described by Vitruvius.

As population increased in Rome and the private houses of the old city were superseded by tall apartment houses (*insulae*), the little gardens were crowded out; but in their stead window boxes of growing plants were introduced "to pasture the eyes on," Pliny says. Roof gardens crowned the city buildings with shrubs, grape arbors, fruit and shade trees, all planted in boxes of earth, while high above the street marble-rimmed fish pools reflected the blue sky or the silent stars.

The Roman type of garden may have been transplanted to Carthage on the conquest of Africa in 146 B. C.; or the conquerors may have occupied unaltered the fine villas that surrounded the Punic capital with their gardens and orchards from early times. In 310 B. C., when Agathocles of Sicily marched on Carthage, he passed through a cultivated and irrigated region, Diodorus tells us, occupied by the landed estates of the Carthaginian nobles, "which they improved for their delight and pleasure." Centuries later villa parks of surpassing beauty still persisted. Aesthetic gardening was a natural development for a people who inherited the principles of Phoenician horticulture, who produced an authority on tillage like Mago, and who, like the Romans, had a rich and privileged class.

Gardens in Spain

Ancient Spain has left no record of pleasure gardens, though, under the favorable conditions of climate and relief, they may have readily developed from the intensive tillage of the native Tartessians and the colonial Phoenicians, Greeks, and Romans who settled on those shores. Strabo (b. 63 B. C.), sailing up the Guadalquivir, described with enthusiasm the beauty of the "orchards and gardens which in this region are met with in highest perfection"; but he failed to specify pleasure gardens. Here at Gades (Cadiz) was born Columella of Roman blood, who more than any other writer on ancient horticulture sang the praises of flowers, as he had seen them grow in his father's gardens beside the Guadalquivir.

With the Saracen conquest in 711 A. D. Spain begins to glow with the beauty of its gardens. The Arab conquerors, conservators of

ancient Mediterranean civilization in an age of barbarian invasions, had already mastered the art of gardening in their eastern homes; they embodied the ideal of their craft in the Moslem dream of paradise. But the environment of Spain produced the perfect efflorescence of this art, because it gave to the craftsman incentive, opportunity, abundant material, and abundant reward. The gardens of Spain became a revelation of the Saracen spirit finer even than the dream of paradise. Here race and environment seem to have combined to produce perfection; but it must not be forgotten that the previous habitat of this conquering race lay among the orchards of apricot and almond, among vineyards and balsam groves, and beside pools and rivulets of Yemen and Mecca. Who tilled those narrow terraces, who watered those slender garden plots earned beauty as well as life.

Many of the old gardens of Granada have survived Christian depredations. The fact that impresses one here is the succession of small gardens incorporated in the architectural mass of the Alhambra and the Generalife—the group of jewel spaces, each in a setting of stone walls or stucco arcade, each exquisite and distinct in itself. Such is the little Patio of Lindaraja with its alabaster fountain, its thicket of roses and myrtle and citron and orange, tempering the noonday glare to a mysterious gloom. Such is the *Jardin los Adarves* with its vine-covered trellises and its blossoming trees looking toward the snowy Sierra Nevada. The Generalife too reveals the charm of small and perfect gardens. Here they glow with sunlit flowers; there they are subdued to deep shade in a sunken water garden, whose green pool is overhung by lines of aged cypresses. This composite grouping recalls the complex garden enclosures of Egyptian Thebes, of Rome, Tibur, Tusculum, and the Naples country; and it makes one realize that the Egyptian Pharaohs, the Roman Caesars, and the Moorish Sultans all planned their gardens after one common model.

The arcade about the Generalife "Garden of the Pond" bears the inscription: "Charming place! thy garden is adorned with flowers which rest on their stalks and exhale sweetest perfumes; fresh breezes stir the orange tree and spread abroad the fragrance of its blossoms. I hear voluptuous music mingled with the rustling of leaves in thy grove. Everything about is harmonious, green, flowering."

"Awake, O north wind; and come, thou south; blow upon my garden that the spices thereof may flow out." East meets West, the garden of Palestine and the garden of Granada.

FLOOD-WATER FARMING

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THE usually clear distinction between irrigated and unirrigated farm land breaks down in the consideration of marginal lands irrigated by flood water. In some instances there is a complete transition, and fairly well designed irrigation systems are maintained to utilize water during the time of heavy run-off in the spring, although enough water may be available for only one irrigation. There are also areas of meadowland that were originally more or less flooded and are now maintained as "wild hay" land by simple diversions and by drainage. But in the western United States there are also many areas, usually of small acreage, where the growth of a crop is dependent on sporadic and muddy floods. No regular system of diversion or of conveyance of water is maintained; but areas selected as likely to be flooded are planted, and those portions of the field not too badly washed by water or covered by silt make the crop. This is flood-water farming, a precarious type of agriculture, long practiced in our Southwest in both ancient and modern times. It should be distinguished from dry farming, in which after each rain the soil moisture is conserved by producing a dust mulch that prevents evaporation.

The two types are alike in that the fields are generally isolated and frequently abandoned. Both types are dependent on the uncertainties of the weather, and hence such fields are called by Spanish-speaking people, *temporales*. The irrigated field is a *labor* or *labor regado*. *Sembrado*, "a planting," is also used as a substitute for *temporal*, as all such fields are more often planted than harvested. As maize, or Indian corn, is the principal crop, the Nahuatl word *milpa* is also used, although more strictly it means a cornfield whether irrigated or not.

Flood-water farming is practiced in the more remote areas of the Southwest and was more prevalent in the early days of settlement than at present. Some recent studies by Quesenberry[1] indicate that it may still play a part in the modern development of the region.

The purpose of this paper[2] is to consider the geographical relation-

[1] F. R. Quesenberry, in an unpublished bulletin of the New Mexico Agricultural College.

[2] Collection of data on flood-water farming has continued over a number of years and was much facilitated during the past season by a grant from the Shaler Memorial Fund of Harvard University. Thanks are also due to J. L. Burkholder, chief engineer of the Middle Rio Grande Conservancy District, Albuquerque, N. Mex., for permission to use material gathered for the district and to Gen. H. F. Robinson, supervising engineer of the U. S. Irrigation Service, Albuquerque, for the use of maps prepared under his direction for other purposes.

ships of the practice of flood-water farming and to consider the decline in acreage in relation to recent changes in stream channels. This complex relationship has also an anthropological importance since flood-water farming was one of the important sources of livelihood of the prehistoric sedentary Indians of the Southwest.

Modern Flood-Water Farming

Save in exceptional places and at altitudes above 6500 to 7000 feet the rainfall of New Mexico and Arizona is ordinarily too scanty to mature crops. At higher altitudes the growing season is short, and in many open valleys among the mountains corn cannot always be matured. Here also the fields are small and the area limited. In the vast, open alluvial basins and on the extensive plateaus of the region large areas of good soil are available. Here, where living waters suitable for systematic irrigation do not exist, flood-water farming has its place.

The areas utilized are variable in size and location, but each is chosen so that the local rainfall may be reinforced by the overflow of water derived from higher ground. The selection of a field involves an intimate knowledge of local conditions. The field must be flooded, but the sheet of water must not attain such velocity as to wash out the crop nor carry such a load of detritus as to bury the growing plants. Such conditions require a nice balance of forces that occur only under special conditions. Shrewd observation and good judgment are necessary in the selection of fields.

The sites chosen fall obviously into two main types: gentle slopes below rock or shale escarpments, valley floors inundated by sheet floods. At sites of the first type the watershed is limited in area and consequently in run-off, but the run-off is large in proportion to the rain. Thus even "little" rains produce a good run-off. The locations of the second type fall into two classes: those where the water of a stream channel spreads out over an alluvial fan at the so-called "arroyo mouth" and those adjacent to large streams which overflow their flood plains. It is obvious, however, that these types more or less grade into each other, and their separation is largely for convenience in description.

Fields below Escarpments

The Spanish-speaking inhabitants of little valleys in the Sandia Mountains, New Mexico, cultivate cornfields at or near their scattered ranches. Settlements were made at these localities about 1815 and reached a more or less stabilized condition in 1850 or shortly after the American conquest. Farming is not the sole resource of these people

FIG. 1

FIG. 2

FIG. 3

FIGS. 1, 2, 3—Cornfields in Gutierrez Canyon, Sandia Mountains, Bernalillo County, N. Mex.

The recently deepened arroyo in the middle ground of Figure 1 no longer overflows the field which is irrigated by the unregulated run-off of the encircling slope.

The fields of Figure 2 below the rocky wooded slope are irrigated only by the unregulated run-off of the slopes; the field in the foreground is irrigated by diversion of flood water.

The cornfield of Figure 3 lies on an alluvial fan on which the flood run-off from a shallow valley in the rocky slope is spread.

FIG. 4

FIG. 5

FIG. 6

FIG. 4—Bean field near Sedillo, Bernalillo County, N. Mex. Irrigated by run-off from the rocky slopes of the background.

FIG. 5—Fields in Arroyo en Medio, view almost due north; note squash plants in the foreground. See Figure 9 for position from which photograph was taken.

FIG. 6—Fields in Arroyo en Medio, view nearly west to sandstone hillock; note destructive wasting in center of view. See Figure 9 for position from which photograph was taken.

as they all own a few head of stock and also cut and haul firewood to Albuquerque twenty miles distant. At various times coal mines and limekilns have flourished. Rough stone for foundations is also gathered and hauled to town. In the past ten years the area has become popular with the inhabitants of Albuquerque for picnics and for the location of summer residences. Land values are rising, and the old order is passing.

A typical field is shown in Figure 1. It lies along the stream of Gutierrez Canyon, a tributary of Tijeras Canyon (Cañon de Carnuel) at an altitude of about 6500 feet. In the background, largely concealed by the scrub cedar (juniper) and piñon trees, is an encircling slope of almost bare sandstone ledges. In a rain, water pours off this slope in a thin sheet. Part is derived directly from the rocky slope, and part is spread on the incipient alluvial cones visible in the view. In the first week in September, when the photograph was taken, the corn was mature and the yield moderately good. In the right foreground is a field not cultivated in 1928. The Gutierrez Arroyo at this place is now about 20 feet deep, whereas according to local inhabitants it was once shallow and inconspicuous. The floods are now confined within the deep channel, whereas once they spread over the borders of the fields and gave to these parts an additional supply of water.

The fields shown in Figure 2 lie about three miles downstream from the area just described. In the middle background, on the far side of Gutierrez Arroyo, the corn plants are small and there are few ears. In 1928 less rain fell at this place than three miles upstream. The field in the foreground has, however, an excellent crop; but it was irrigated by flood water diverted from the arroyo by a crude dam. On several critical occasions water came down the arroyo when there was no local rainfall. The contrast in productiveness of the two fields is marked. In the early days, when Gutierrez Arroyo was less deep, simple diversions of such a character were easy and much more numerous.

Beans are also planted under somewhat similar conditions, and such a field is illustrated in Figure 4. This is near the town of Sedillo and at a little higher elevation than the fields previously described. More dependence is placed on the somewhat greater average rainfall. Nevertheless, this field is flooded by the run-off of the surrounding hills, which is only partly concentrated in the curving channel that runs through it.

A transition type is shown in Figure 3. This field is also in Gutierrez Canyon and is located on the alluvial fan of a tributary. The beans planted in the plowed strip, in the middle ground between the isolated tree and the arroyo, failed to receive much water and by September were shriveled and dry.

Fields at the "Arroyo Mouth"

In the Papago country of southern Arizona the flood run-off of the mountain areas is gathered in streams with well defined channels which on reaching the great undissected alluvial basins spread out into sheets. The place where this spreading occurs is called by the Papago Indians *Ak-Chin*, "arroyo mouth." These are favorite

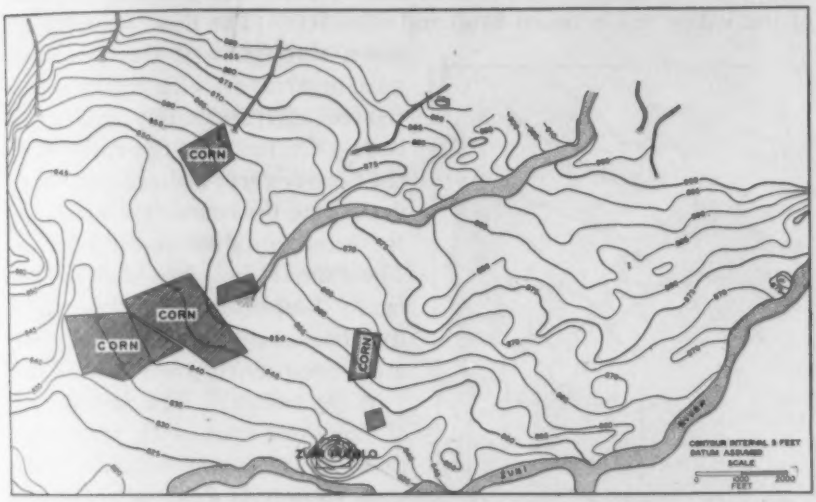

Fig. 7—Map of part of Zuñi Valley, McKinley County, N. Mex., showing areas fenced for cultivation of corn in 1908 before irrigation of the valley by water stored in Zuñi Reservoir. (Redrawn from map by U. S. Indian Irrigation Service).

situations for flood-water fields, and more than six villages or localities once inhabited in Arizona and Sonora are called Ak-Chin or a corrupted form of the same name.

Localities where flood waters derived from a channel or arroyo spread out in a sheet are fairly common, but they have been much reduced in number by the recent trenching of the channels of streams. In Zuñi Valley, McKinley County, New Mexico, such localities have always been used for fields by the Zuñi Indians. In 1906 the U. S. Indian Irrigation Service began the construction of an irrigation system for these Indians, and a topographic map of the land to be irrigated was made in 1908 (scale 1 inch to 500 feet; two-foot contour interval). Part of this map, with a much reduced scale and a five-foot contour interval, is reproduced in Figure 7. The Zuñi River runs in a well defined arroyo which at that time had banks 15 to 20 feet high. Since the completion in 1908 of the Zuñi Dam, nine miles east of Zuñi Pueblo, only small quantities of water have been carried by the river. The sand contributed by two large arroyos that enter the river below the dam has filled the channel at least four feet at Zuñi Pueblo. The deep channel of Zuñi River is relatively recent and, as

indicated by a study of early surveys, was cut between 1880 and 1902, or in the general period when channel trenching took place in the Southwest.

The lateral tributaries of Zuñi River, except the two previously mentioned, are not entrenched. They arise in the intricately carved borders of the neighboring mesas. These mesas of red shale and red and white sandstone rise to elevations of 7000 feet, whereas the floor of the valley lies between 6100 and 6200 feet. The flood waters pour down through well defined channels, or arroyos, with banks five to ten feet high and sandy or gravelly beds. On reaching the valley floor the floods overflow the channel and, depositing the coarser material near the bank, produce natural levees. The channel becomes shallow and finally disappears. The place where the channel disappears is the place most frequently overflowed, the "arroyo mouth." The distribution of fields in 1908 with respect to these arroyos was notable. The area shown as field is about 165 acres; but these are the fenced areas, and, according to the usual practice, only parts of these areas were actually planted and still smaller parts were harvested. At various places in the valley floor low mounds are shown by the contours, and there are also undrained depressions. These mounds are piles of wind-blown sand which are effective in the spreading of flood waters.

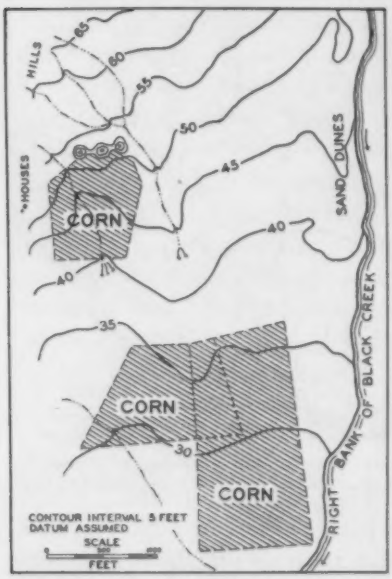

FIG. 8—Map of part of Red Lake Irrigation Project, Navajo Reservation, N. Mex., showing areas fenced for cultivation of corn in 1925 before irrigation by water stored in Red Lake Reservoir. (Redrawn from map by U. S. Indian Irrigation Service).

Another illustration, on the Red Lake Irrigation Project within the Navajo Reservation in northwestern New Mexico, is given in Figure 8.

FIELDS IN MAIN VALLEYS

Examples of flood-water fields in main valleys are now rare. The deepening and widening of stream channels in late years has been so complete that few undissected valleys remain.[3]

Such an undissected valley is that of Arroyo en Medio, a tributary

[3]Kirk Bryan: Date of Channel Trenching (Arroyo Cutting) in the Arid Southwest, *Science*, Vol. 62 (N. S.), 1925, pp. 338–344; *idem:* Historic Evidence on Changes in the Channel of Rio Puerco, etc., *Journ. of Geol.*, Vol. 36, 1928, pp. 265–282.

of the Rio Puerco by way of the Arroyo Torreones (Torrejon) and the Arroyo Chico. The valley is 11.5 miles long, and the drainage area is about 30 square miles. A deep channel, or arroyo, has cut back from Arroyo Torreones a distance of a mile and a half. At its junction with Arroyo Torreones this arroyo is 22 feet deep and 28 feet wide. The head is a chaos of gullies and blocks of clay, a sign of active headward erosion. Downstream from this point all the flood water is confined in the channel, and the valley floor is no longer overflowed.

About a quarter of a mile above the head of the arroyo the valley floor is occupied by fields, embracing 55 acres, cultivated by Navajo Indians. The valley floor above the fields is narrow and marked by a deep channel which holds any ordinary flood. In one place it is 15 feet deep, but for the most part it is from 5 to 12 feet deep. Near the sandstone ledge that almost blocks the valley the channel disappears and the flood waters spread out. This process was originally entirely natural, but at present it is more or less aided and controlled by the Indians. The spreading waters deposit part of their load of silt, so that the field is softer and also sandier than most parts of the valley floor. In places the currents are so swift as to destroy the corn, but in general the crop is good. The new deep channel, or arroyo, as it works headward, menaces the fields, which before many years must, like so many others, be abandoned.

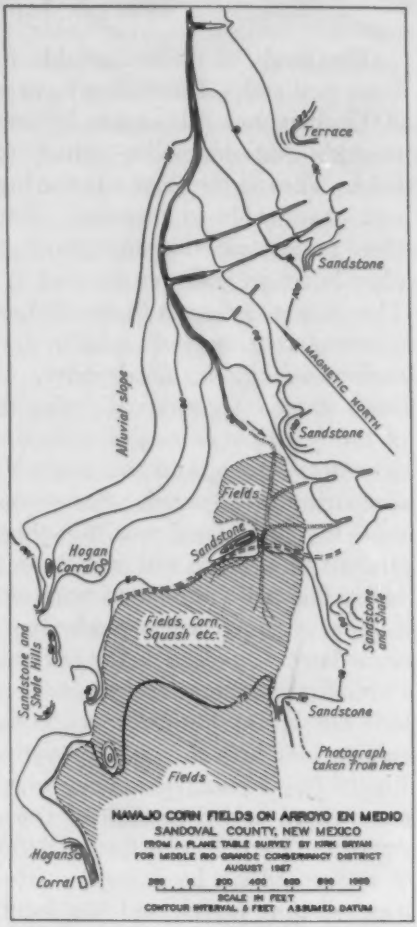

FIG. 9—Map of fields cultivated by Navajo Indians in Arroyo en Medio, Sandoval County, N. Mex. Compare Figures 5 and 6.

In 1928 a smaller group of fields similar in location was being cultivated in Cañada de la Piedra Lumbre, a companion tributary of Arroyo Chico. Similar places in various parts of the plateaus in northwestern New Mexico and northern Arizona are cultivated nearly every year, especially on the Navajo Reservation, where, according

to Gregory, 20,000 acres were farmed with flood water in the period from 1909 to 1915.[4]

Contrast between Indian and Spanish Farming

The kinds of places suitable for farming under the system have been outlined. These sites have existed from the time of prehistoric settlement; but cultivation, by its disturbance of the surface, leads to washing and channeling, which temporarily or permanently ruin a field. Thus at the same site the best places to plant are limited in area and changeable in position. The Indians of the present day, like their prehistoric ancestors, hardly disturb the ground, as they do not plow but merely insert the seed in a hole made with a planting stick. They select each spot that is to be seeded and by deep planting assure a strong root system capable of resistance to drought and to some surface washing by flood water. Even with the use of their methods fields must be periodically abandoned for later reoccupation. One of the principal causes of such shifts in location lies in the habits of ephemeral streams in the stage of alluviation. Such a stream has a discontinuous channel. For several hundred yards or for a mile or more it runs in flood as a thin sheet. As there is no low water or permanent flow, there will be left, on the recession of the flood, a smooth valley floor with almost no trace of a channel. Downstream from such a flat a channel begins suddenly and may be from 2 to 20 feet deep, according to the size of the ordinary flood that is to be carried. This channel may continue for yards or miles and then rather suddenly fade out in another channel-less flat. The flats are the best sites for cultivation, and the characteristics of such areas are well shown in Figure 9. These phenomena are obviously due to adjustments between load and discharge of the stream for the maintenance of as smooth a grade as possible. Obviously also, with variable discharges of water and silt by tributary streams, the proportionate load of the main stream varies, and the location of the discontinuous channels and broad flats varies in position through the years. The best situations for fields also vary with these changes.

To the Indian such shifts were usually of little importance as he farmed only for subsistence and was accustomed to walk long distances from his village to his fields. The Papagos[5] and Hopis even today cultivate such fields 20 to 30 miles from their winter residences. These long distances are frequently traveled afoot, and before the Spanish conquest the crop was carried home on the backs of men and women.

[4] H. E. Gregory: The Navajo Country, *U. S. Geol. Survey Water-Supply Paper 380*, Washington, 1916, pp. 103–105.

[5] J. W. Hoover: The Indian Country of Southern Arizona, *Geogr. Rev.*, Vol. 19, 1929, pp. 38–60; reference on pp. 49–55.

The Spanish conquest introduced two new factors into the practice of flood-water farming. The most important was live stock. Cattle and particularly horses spread far beyond the Spanish settlements and immediately brought about the need of fences. The presence of domesticated animals increased the use of corn, which had been used only for men and turkeys, and the availability of pack animals caused trade to flourish and the value of corn to rise. Thus larger acreages were required, and at the same time the labor of growing crops increased by reason of the fences. The labor is somewhat mitigated by the use of horses and plows in cultivation and of horses and wagons for transportation of the crop. These changes placed agriculture on a more modern and commercial basis—a change which the Indians have resisted so far as possible. Thus one can still find in the more remote districts unfenced fields planted without being plowed.

The Spanish attempted so far as possible to use the same fields continuously and, having iron tools and draft animals, built dams and ditches. So far as possible they attempted to control the floods, and wherever they failed to do so they were heavy losers.

With the American conquest in 1846 the marauding Navajo, Comanche, and Apache were gradually subdued. Settlement spread from the areas of the Spanish and Mexican grants into the public domain. Here the operation of the homestead laws hampered flood-water farming. Only one piece of land could be legally acquired, whereas the settler needed permanent water and one or more fields, *temporales*, which usually could not be found together in one tract of 160 acres. Hence a further inducement was offered for retention in permanent cultivation of flood-water fields. The use of plows and the presence of live stock made surface washing even more common. Consequently many fields were abandoned long before or quite independently of the deepening and widening of stream channels which began about 1880.

Effect of the Recent Epicycle of Erosion

It appears that before 1880 farming by flood water was more extensive then at present. In the main stream valleys, such as the Rio Puerco, it was a thriving business. Here the Spanish-speaking New Mexicans settled about 1870 and built simple diversion works and ditches. In general they were more independent of local conditions than were the Indians, as they had iron and steel tools and live stock. Log and brush dams and at least a short length of permanent main ditch were usually constructed. Juan Bandera, who came from Texas and settled near San Ignacio in 1882, told me that low brush dams were thrown across the channel during later phases of a flood, and the water was diverted into ditches or simply warped over the land. At

times of great floods the whole valley floor was inundated and so saturated that no further irrigation was necessary that year. Near Cabezon the channel of the river was so shallow that, according to the recollection of Meliton Chaves, one man could divert the water by felling a cottonwood across the channel and using the branches to make a dam.

Such simple diversions are no longer possible. Only two dams are maintained in the hundred-and-fifty-mile Puerco Valley. These structures, at Cuba and San Luis (Dominguez P. O.), are elaborate contrivances of logs and rock which require much effort to maintain. Along this great stream, because of the deepening of the channel, six small towns and numerous ranches have been abandoned.

On the Rio Galisteo, an ephemeral tributary of the Rio Grande from the east, there were at one time several thriving agricultural settlements. All the farm lands are now abandoned, although some of the towns survive as trading points and headquarters for stock raisers.

The town of Colorado, locally called Coloradito, lay three miles south of Lamy, a station on the Atchison, Topeka and Santa Fe Railway. In the U. S. Land Office Survey of 1883 William White states in his notes[6] that the town had "about 10 houses." The Lamy sheet of the U. S. Geological Survey, which was surveyed in 1890, shows 11 houses and some outlying ranches. But this town has now been deserted for more than twenty years. The inhabitants found it increasingly difficult to maintain a dam across the channel of the Galisteo, which continuously increased in width and depth. Their lands were finally purchased for grazing purposes.

At Galisteo, still a thriving town with gardens irrigated by well water pumped by windmills, J. S. Garretson states in his notes of 1850 that there were cornfields. John Shaw repeats this statement in his notes of 1879.[7] Later surveyors fail to mention cultivation of the land. According to local authorities the arroyo began to deepen about 1884, and cultivation by flood water became increasingly difficult and was abandoned by 1900. And so for various other places.

The accelerated erosion that has been going on since about 1880 has restricted flood-water farming to smaller and more scattered areas and terminated it in the main valleys. The shifts in population that have been brought about by this change in agricultural conditions have been inadequately studied. The number of people involved is relatively small, but the areas are large. With further study of local history many additional examples of these movements of population will be put on record.

In the light of the relation between the state of erosion in stream

[6] On file in the Public Land Office, Santa Fe, N. Mex.

[7] The notes of Garretson and Shaw are also on file in the Public Land Office, Santa Fe, N. Mex.

channels and agriculture the present aspect of the region is deceptive. An accelerated rate of erosion leads to misconceptions in attempts to interpret the life of the prehistoric peoples. Small and large ruins occur in places that appear at present to be barren wastes; yet excavation shows that these ruins were occupied by the ancestors of the modern Pueblo Indians who were as well provided with this world's goods as most of their descendants. These ancients practiced agriculture with maize, beans, and squash as their crops. How, then, did they thrive?

Obviously some of the ruins represent unprofitable ventures, for the ancients could not have been infallible in the choice of town sites. Many ruins, however, testify to long occupation; yet they lie far from living streams and where ordinary irrigation is impossible. Nor does it seem likely that in the past there could have been such a moist climate as would provide living waters in any of the near-by valleys. In fact, there is strong negative evidence against this suggestion, since perennial streams leave characteristic deposits which have not as yet been detected in the alluvium of such valleys. If, however, agriculture by the use of flood water is assumed as the prevalent habit of the prehistoric peoples, the sites of many ruins seem more propitiously located. The abandonment of the sites may also be explained.

According to an authoritative summary by Kidder the Pueblo culture began in small scattered settlements of single houses or small groups of houses.[8] Large communal aggregations, the pueblos, were then built; and this stage is the great epoch of the Pueblo culture. The area occupied by these people extended from southwestern Nevada through most of Utah and part of southern Colorado southward over most of eastern Arizona and the western two-thirds of New Mexico.

In the succeeding stages and before the Spanish conquest the number of villages and the area in which they were distributed were reduced. There was a concentration toward the Rio Grande Valley, and at many places the people appear to have practiced irrigation with living water. Yet even at the time of the Spanish conquest the Hopi, Zuñi, Acoma, Tano, and part of the Tigua and Piro peoples must have been largely dependent on farming by flood water.

A cycle of erosion similar to that of the present, accompanied by trenching of stream channels, drainage of moist valley flats, and great restriction in farming by flood water, would have been an adequate cause for the abandonment of many previously occupied regions. It would have been most effective in the peripheral regions occupied by the Pueblos and may easily have been the cause that brought the Great Pueblo period to an end.

[8] A. V. Kidder: An Introduction to the Study of Southwestern Archeology, New Haven, 1924, pp. 36–46 and 54–55.

That such a cycle of erosion took place in prehistoric time and was succeeded by a period of alluviation that continued down to about 1880 is supported by an increasing body of fact. A buried channel representing such a cycle of erosion and alluviation has been found at Chaco Canyon and at other localities, notably on Rio Galisteo.[9] The channel formed and filled at about the end of the Great Pueblo period. The collection of data on this episode is still going on, but it appears that an adequate physical cause for the decline in Pueblo culture from its peak and the shifts in population at about that time is in sight. Such an explanation rests on the postulate that flood-water farming was the principal support of the prehistoric people.

Dry Farming of Beans as a New Industry

During the World War the prospect of a shortage of food led to an artificial stimulation of the growing of the pinto bean, a large, speckled, brown bean widely distributed through northern Mexico. The Spanish-speaking people of New Mexico, well aware of the risk of loss, increased the production of beans to about six times the normal. The price was lower than that of white beans, and a market outside the state was found. Since that time the market has expanded, and large areas of grassy plains at the higher altitudes have been used for growing beans. Even with the best dry-farming methods the business is hazardous, and in some years there are total failures. Overflows by the run-off of higher ground are extremely valuable in reënforcing the moisture derived from local rainfall. It seems likely that further study of the primitive methods of flood-water farming will lead to modern adaptations that will be applicable to the otherwise promising business of growing pinto beans.

[9] Kirk Bryan: Recent Deposits of Chaco Canyon, New Mexico, in Relation to the Life of the Prehistoric Peoples of Pueblo Bonito (abstract). *Journ. Washington Acad. of Sci.*, Vol. 16, 1926, pp. 75–76.

THE GULF STREAM AND ITS PROBLEMS

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MAURY'S "The Physical Geography of the Sea," which appeared in 1855, is frequently referred to as the first textbook of modern oceanography. In that work the author devotes the first chapter to the Gulf Stream, introducing it thus:

> There is a river in the ocean. In the severest droughts it never fails, and in the mightiest floods it never overflows. Its banks and its bottom are of cold water, while its current is of warm. The Gulf of Mexico is its fountain, and its mouth is in the Arctic Seas. It is the Gulf Stream. There is in the world no other such majestic flow of waters. Its current is more rapid than the Mississippi or the Amazon.[1]

Even in matters scientific, customs change. It is altogether unlikely that an oceanographer nowadays would speak of the Gulf Stream as rhetorically as did Maury. The magnitude of this current, however, is such that even later students make use of superlatives in describing it. The most comprehensive investigation of the Gulf Stream was carried out between the years 1885 and 1889 by Lieutenant (later Rear Admiral) J. E. Pillsbury, U. S. N., while attached to the Coast and Goedetic Survey. And when he came to write up the results of his observations and studies he described it as "the grandest and most mighty . . . terrestrial phenomenon."[2]

Of all the currents that make up the systems of oceanic circulation, the Gulf Stream has received the greatest amount of study and is the best known. Its discovery, or more accurately the first notice on record, came shortly after the discovery of the new world. Early in March of 1513, Ponce de Leon set sail from Porto Rico with three ships on a voyage of exploration. Setting a northwesterly course the expedition discovered Florida, a landing being made on the eastern coast somewhere in the general vicinity of Cape Canaveral. Sailing southerly then they encountered on April 22, as related in a chronicle of the expedition, "a current such that, although they had a great wind, they could not proceed forward, but backward, and it seemed that they were proceeding well; and in the end it was known that it was in such wise the current which was more powerful than the wind."[3] Thus was the Gulf Stream first noted.

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[1] M. F. Maury: The Physical Geography of the Sea, New York, 1855, p. 25.

[2] J. E. Pillsbury: The Gulf Stream: Methods of the Investigation, and Results of the Research, Appendix No. 10 of *Rept. of the Supt. of the Coast and Geodetic Survey for 1890*, Washington, D. C., 1891, pp. 459–620; reference on p. 472.

[3] L. D. Scisco: The Track of Ponce de Leon in 1513, *Bull. Amer. Geogr. Soc.*, Vol. 45, 1913, pp. 721–735; reference on p. 725.

Apparently the Spaniards soon learned that this northerly-flowing current was not merely a local current but one of wide extent; for six years later, when Antonio de Alaminos set out for Spain from Vera Cruz, he sailed northward with the Gulf Stream for a number of days before turning east toward Europe. This same Alaminos was pilot of Ponce de Leon's expedition of 1513 when the Gulf Stream was first noted. It is therefore quite proper to credit the discovery of the Gulf Stream to Alaminos.

Earliest Gulf Stream Chart

For two and a half centuries following its discovery the growth of knowledge regarding the Gulf Stream was slow. The story is told in detail by Kohl[4] and more briefly by Pillsbury. During this period, to be sure, the mariner and more especially the whaler became acquainted with the Gulf Stream throughout the greater part of its course. Much of this information, however, was kept as a professional secret, and it was not until after the middle of the eighteenth century that the course of the current was depicted on a chart. The story of how this came about is not without interest, especially as it illustrates nicely the effect of the Gulf Stream on navigation.

About 1770 complaint was made to the London officials that the English packets which came to New York took about two weeks longer in crossing than did the Rhode Island merchant ships which put in at Narragansett Bay ports. Benjamin Franklin, being in London at the time, was consulted about the matter. To quote his own words:

> It appearing strange to me that there should be such a difference between two places, scarce a day's run asunder . . . I could not but think the fact misunderstood or misrepresented. There happened then to be in London, a Nantucket sea-captain of my acquaintance, to whom I communicated the affair. He told me he believed the fact might be true; but the difference was owing to this, that the Rhode-Island captains were acquainted with the gulf stream, which those of the English packets were not . . . When the winds are but light, he added, they are carried back by the current more than they are forwarded by the wind . . . I then observed that it was a pity no notice was taken of this current upon the charts, and requested him to mark it out for me, which he readily complied with, adding directions for avoiding it in sailing from Europe to North-America.[5]

Franklin goes on to relate that he had the information engraved "on the old chart of the Atlantic, at Mount and Page's, Tower-hill; and copies were sent down to Falmouth for the captains of the packets who slighted it however; but it is since printed in France, of which edition I hereto annex a copy." (Fig. 1.)

[4] J. G. Kohl: Geschichte des Golfstroms und seiner Erforschung von den ältesten Zeiten bis auf den grossen amerikanischen Bürgerkrieg, Bremen, 1868, pp. 1–114.

[5] A letter from Dr. Benjamin Franklin, to Mr. Alphonsus le Roy, Member of Several Academies, at Paris: Containing Sundry Maritime Observations, *Trans. Amer. Philos. Soc.*, Vol. 2, 1786, pp. 294–329; reference on pp. 314–315.

As evidenced by Franklin's letter in the *Transactions of the American Philosophical Society*, the Gulf Stream towards the end of the eighteenth century became a subject of scientific investigation and discussion. Franklin himself made observations on the temperature of the sea water during a number of voyages and noted with regard to the Gulf Stream "that it is always warmer than the sea on each side

FIG. 1—Franklin's chart of the Gulf Stream.

of it." By the middle of the nineteenth century, when systematic observations were begun, a fund of information had been gathered from navigators' logs and from the observations of scientifically-minded travelers.

SYSTEMATIC OBSERVATIONS

Systematic observations in the Gulf Stream were begun in 1845 by the Coast Survey under the superintendency of Alexander Dallas Bache, a grandson of Franklin. At different times up to the year 1889 specially equipped vessels were detailed for the work, the results being published as appendixes to the annual reports of the Superintendent of the Coast and Geodetic Survey, the last one being that by Pillsbury cited in footnote 2. In passing, it is to be noted that this systematic work was confined almost wholly to the Gulf Stream along the coast of the United States.

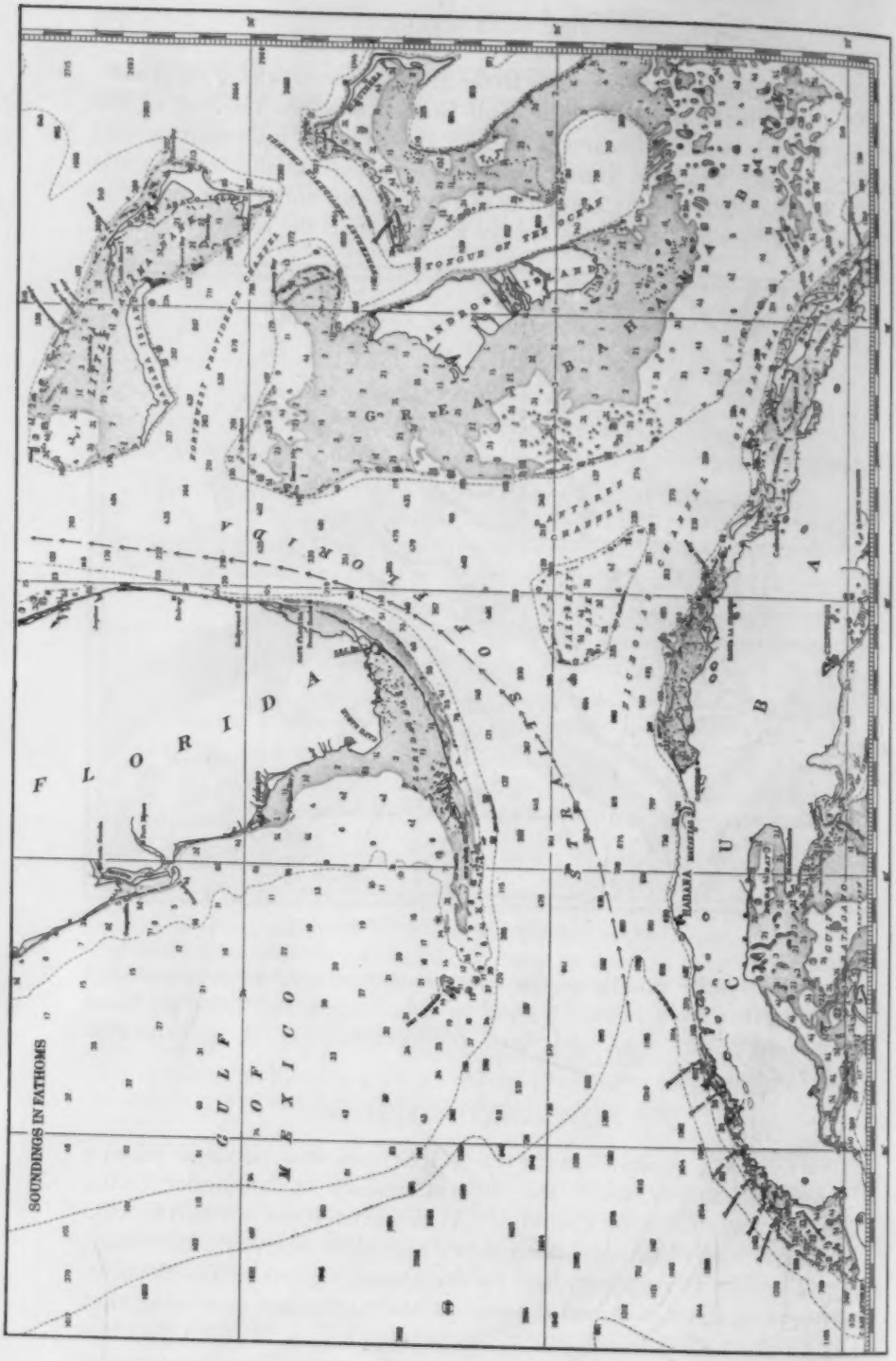

FIG. 2.—Hydrographic features of the Gulf Stream within the Straits of Florida. (Adapted from U. S. Coast and Geodetic Survey Chart 1007.)

The published material on the Gulf Stream is extensive. Here it will be sufficient to direct attention only to the more authoritative recent work. Krümmel, in what is still the standard textbook of oceanography,[6] gives a brief but critical summary of the hydrographic features of the Gulf Stream as developed to the end of the first decade of the present century, and Schott[7] brings the discussion up to the present time. And, while dealing with but a restricted part of the Gulf Stream, Wüst's study[8] should be mentioned here because it represents a successful attempt to correlate and elucidate the phenomena involved in the Gulf Stream by means of mathematical, or more accurately perhaps, dynamical methods.

It is customary to trace the last remnant of the Gulf Stream into the Arctic waters north of Norway. From its place of origin in the Gulf of Mexico, therefore, this current traverses a route of more than six thousand miles. But it is not as a "river in the ocean" that it manifests itself throughout its course. The phenomena presented are much more involved, and the Stream is to be regarded rather as a complex system of currents than as a single current. We may arrive at an understanding of the nature of the forces and factors involved by a brief consideration of its characteristics in the region in which it has been most carefully studied.

The Current in the Straits of Florida

It is in its first reach, through the Straits of Florida, that the characteristics of the Gulf Stream are most marked. Here its waters have the highest temperature and salinity and the swiftest flow. And because it is here confined within a restricted channel it lends itself more readily to investigation. Observations have here been made across a number of sections; and with this stretch, too, Wüst's study mentioned above is concerned.

Figure 2, which is adapted from Coast and Geodetic Survey Chart 1007, visualizes the hydrographic features of the Gulf Stream for the first 400 miles of its course. The region where the Gulf of Mexico narrows to form the channel between Florida Keys and Cuba may be regarded as the head of the Gulf Stream. Here the width of its channel is 95 nautical miles. Eastward the channel becomes narrower, reaching its least width in the so-called Narrows, abreast of Cape Florida, where it is but half its original width. From here it widens somewhat until it meets the open sea north of Little Bahama Bank.

While the chart shows that in its first reach the Gulf Stream flows between banks like a river, it is to be noted that this channel is in two respects markedly different from that of a river. In a river, as a

Fig. 2.—Hydrographic features of the Gulf Stream within the Straits of Florida. (Adapted from U. S. Coast and Geodetic Survey Chart 1007.)

[6] Otto Krümmel: Handbuch der Ozeanographie, 2 vols., Stuttgart, 1907–1911.

[7] Gerhard Schott: Geographie des Atlantischen Ozeans, 2nd edit., Hamburg, 1926, pp. 180–205.

[8] Georg Wüst: Florida- und Antillenstrom, *Veröffentl. Inst. für Meereskunde*, No. 12, 1924, Berlin.

rule, the channel increases in width from head to mouth. But in the Gulf Stream, as we have just seen, the width of the channel decreases seawards. Furthermore, a river deepens as it goes seaward; an examination of the chart, however, shows that the channel of the Gulf Stream becomes shallower as it goes seaward. At its head, as shown in Figure 2, the Stream shows depths of a thousand fathoms or more; but the depths gradually decrease, and when the channel approaches the sea the greatest depth is but little more than 400 fathoms.

Nautical charts are issued primarily for the mariner, to whom the shoal areas are critical. Hence in hydrographic surveys, as a rule, shoal areas are much more closely developed than areas of deep water. So that it may be assumed that the relief of the bottom of the Straits of Florida is indicated only in its larger features on the chart. It is quite likely that a detailed hydrographic survey of the Straits would bring out interesting local features that now are masked.

Throughout the whole stretch of four hundred miles shown in Figure 2, the Gulf Stream flows with considerable velocity. It is clear, however, that the whole mass of water is not moving with a uniform velocity. Confining our attention for the present to the velocity of the current at the surface we find at its head, say abreast of Havana, the velocity in the axis of the stream (shown by arrows in Figure 2) to be about 2½ nautical miles per hour, or 2½ knots on the average. Seaward, the velocity increases gradually as the cross-sectional area of the Stream decreases until abreast of Cape Florida the velocity becomes about 3½ knots. As we shall see later, the current is subject to variations; and it is therefore to be emphasized that the velocities given above are approximate average or normal velocities.

With regard to the current within the depths of the Gulf Stream the observational data are in general fragmentary. Pillsbury during his investigation carried out several series of current observations in the Straits of Florida, but these were generally confined to depths less than 1000 feet. From these observations and from general considerations it is known that the swiftest thread of the current lies in the axis of the Stream, just below the surface, and from here the velocity decreases with increasing depth. In the axis of the Gulf Stream, off Havana, Pillsbury found the current setting easterly with a velocity of a knot at a depth of 130 fathoms.

Within the narrows of the Strait, abreast of Cape Florida, the velocity distribution may be considered relatively well known. Figure 3, adapted from Wüst, shows the velocity distribution across the section just south of Cape Florida. In constructing the velocity curves Wüst made use of Pillsbury's observations; and for the deeper parts, for which no observations are at hand, he derived the necessary data from a consideration of the temperature and salinity observations, which here extend from the surface to the bottom.

Within the Straits of Florida the Gulf Stream is generally pictured as a swiftly moving stream with but little variation in velocity from surface to bottom. Figure 3 shows, however, that only within a layer of about 200 fathoms (1200 feet) does the velocity exceed one knot. Moreover, near the bottom, Pillsbury found the current setting southerly, that is in a direction opposite to that of the main stream. This was taken to indicate a southerly flowing current, deriving perhaps from the Labrador Current. It appears, however, that it is more reasonably to be ascribed to eddies brought about by the upward-sloping bottom within the Straits of Florida.

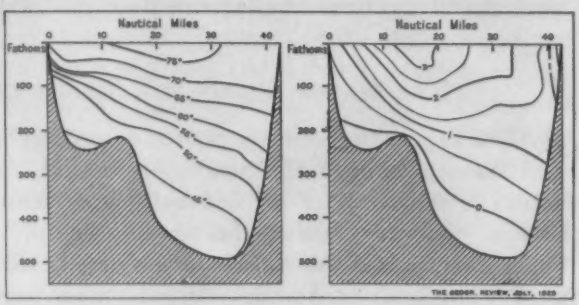

FIG. 3—Cross sections showing the temperature (left) and velocity (right) of the Gulf Stream waters within the Straits of Florida. (After Wüst.)

With the details of the velocity distribution known, it becomes possible to compute the volume of water discharged by the Gulf Stream through the Straits of Florida. A rough estimate is easily made from Figure 3. In round numbers the channel eastward of Cape Florida has a width of 42 (geographical) miles and an average depth of 2000 feet, or approximately one-third of a mile. This gives the area of the cross section here as 14 square miles. In round numbers, also, the velocity of the current through this section may be taken as one knot. Each hour, therefore, the Gulf Stream carries 14 cubic miles of water past this section into the sea. Since a geographical mile has a length of 6080 feet and a cubic foot of sea water weighs approximately 64 pounds, we find that each hour the Gulf Stream carries 100 billion tons of water past Cape Florida into the sea.

The above calculation is clearly no more than a rough estimate; but it demonstrates that the hourly volume of the Gulf Stream is to be reckoned in scores of billions of tons. On the basis of his observations Pillsbury calculated the hourly volume of the Gulf Stream through the Straits of Florida as 90 billion tons. More recently Wüst, on the basis of data furnished by the observations and amplified by dynamical considerations, derived for this volume 89.96 cubic kilometers, or 14.1 cubic miles, which equals 101½ billion tons. In round numbers we may therefore take the average hourly volume of the Gulf Stream through the Straits of Florida to be 100 billion tons.

We may perhaps appreciate better the enormous volume of water that the Gulf Stream pours into the sea by comparing it with the volume discharged by the Mississippi River, which drains more than

40 per cent of the area of continental United States. On the average the Mississippi discharges about 664,000 cubic feet of water into the Gulf of Mexico each second. At extreme flood stage this volume becomes multiplied about threefold, mounting to about 1,800,000 cubic feet per second.[9] On converting these figures into cubic (geographical) miles per hour they become respectively 0.01 and 0.03 cubic mile. The 14 cubic miles which the Gulf Stream hourly pours into the sea is thus more than 1000 times the average discharge and very nearly 500 times the extreme flood discharge of the Mississippi.

The Water Within the Straits of Florida

With regard to the water poured so prodigally by the Gulf Stream into the sea through the Straits of Florida, the generally accepted notion is that it is of an unusually high temperature from top to bottom. Figure 3 shows the temperature of the water, in degrees Fahrenheit, across the section in the Straits from Cape Florida eastward. This is adapted from Wüst, who made use of observations taken in May, 1878, and in March, 1914. Since, in general, the sea in the northern hemisphere is coldest in February and warmest in August, it may be taken that the temperatures shown in Figure 3 are approximately average temperatures.

Obviously the Gulf Stream in the Straits is not a homogeneous body of warm water. At the surface, in the center of the channel, the temperature is about 80°, and at the bottom it is 45° or even less. The fall in temperature is fairly rapid, a temperature of 50° being attained at about 200 fathoms, so that only a relatively shallow layer of the water is warm.

Figure 3 brings to light the fact that for any given depth the water on the eastern side of the channel is considerably warmer than that on the western. Thus at a depth of 100 fathoms the water on the Florida side of the Straits has a temperature of about 50°, while on the Bahama side the temperature is about 70°. Furthermore, while the change in temperature with depth is approximately uniform on the Bahama side, it is decidedly non-uniform on the Florida side, where a rapid change of 20° in temperature takes place between the depths of 50 and 100 fathoms. As regards temperature therefore, the water of the Gulf Stream is decidedly not homogeneous.

The prevailing conception of the Gulf Stream as an unusually warm body of water can be shown as erroneous from another point of view; namely, by comparison with other bodies of water in the same latitude, for example, with the Sargasso Sea. The surface waters of the Gulf Stream in the Straits of Florida have about the same temperature as the

[9] J. L. Greenleaf: The Hydrology of the Mississippi, *Amer. Journ. of Sci.*, Ser. 4, Vol. 2, 1896, pp. 29–46; reference on p. 42.

surface waters of the Sargasso Sea. But within the depths the Sargasso Sea is much warmer. At a depth of 200 fathoms the temperature of the latter is between 60° and 65°[10], while in the Gulf Stream at that depth the temperature, as shown by Figure 3, averages about 55°.

With regard to other characteristics there is a like tendency to overrate the waters of the Gulf Stream. Highly saline these waters are, but not exceptionally so. On the customary salinity scale, in which each unit represents one part of salt in a thousand parts of water, the surface waters within the Straits have a salinity of about 36. Below the surface the salinity increases gradually until a maximum of 36½ is reached at a depth of about 100 fathoms, after which the salinity decreases to about 35 at 300 fathoms, which salinity is then maintained to the bottom. In round numbers we may take the salinity of the waters within the Straits as a whole to be 36. Compared to the average salinity of 34¾, which is accepted as the figure for the sea as a whole, the water within the Straits is highly saline; but toward its eastern end the Sargasso Sea is more saline, having a salinity of 37½ on the surface and of about 36 at a depth of 300 fathoms. In depth of color and transparency the waters in the Sargasso Sea likewise exceed those of the Gulf Stream.

In general, however, the Gulf Stream as it issues into the sea through the Straits of Florida may be characterized as a swift, highly saline current of blue water whose upper stratum is composed of warm water.

Union with the Antilles Current

On issuing into the sea north of Little Bahama Bank the Gulf Stream loses the relatively great velocity which characterized it within the Straits. From 3½ knots along the axis within the narrows of the Straits there is a gradual decrease to a velocity of about two knots off St. Augustine, Fla., in latitude 30° N. Here the Gulf Stream is joined by the Antilles Current, which flows northwesterly along the open ocean side of the West Indies before uniting with the Gulf Stream.

North of the thirtieth parallel of latitude, therefore, the Gulf Stream is a current to which two branches have contributed. It is no longer merely a continuation of the current that flows through the Straits of Florida. The latter current, for distinction, is frequently referred to as the Florida Current. As to the relative importance of the two branches of the Gulf Stream widely varying opinions have been entertained. Formerly it was thought that the Antilles Current furnished both the greater quantity of water as well as the greater quantity of heat transported by the Gulf Stream. Krümmel, for example, credits the Antilles Current with contributing about 2¾

[10] Schott, *op. cit.*, Pl. XIV, following p. 144.

times as much water and heat as the Florida Current. Wüst's study of the question, however, makes it appear that the rôles of the two currents must be reversed; for he finds, on the basis of later data, that the Florida Current contributes about twice as much water and heat as the Antilles Current.

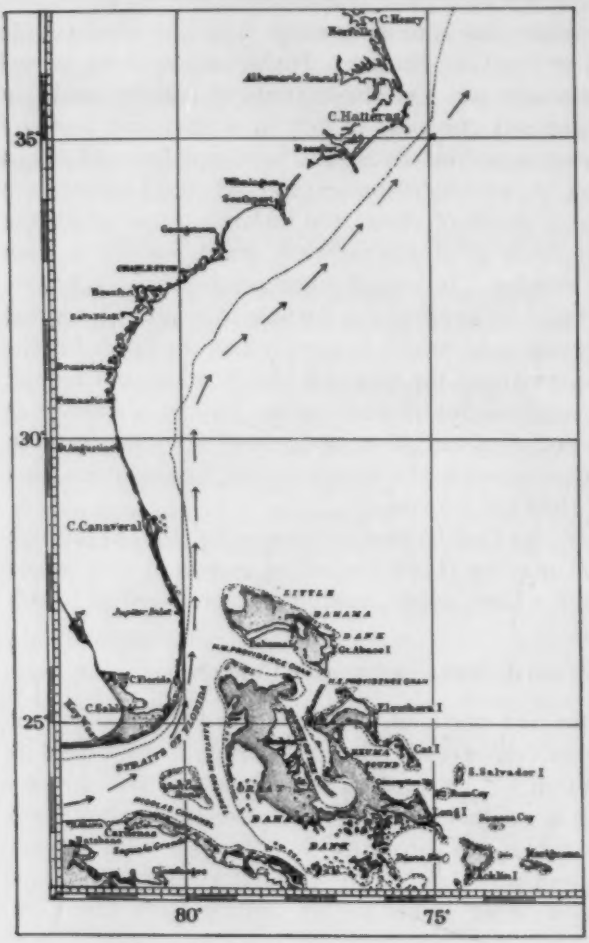

FIG. 4—The axis of the Gulf Stream. The dotted line represents the 100-fathom line.

The Antilles Current, like the Florida Current, carries warm, highly saline water of clear indigo blue. The union of the two currents gives rise to a broad current possessing about the same characteristics as the Gulf Stream within the Straits except that the velocity is much reduced. The combined current under the influence of the deflecting force of the earth's rotation and the easterly-trending coast line turns more and more easterly, so that off the coast of Georgia the Gulf Stream bears northeast, maintaining this general direction past Cape Hatteras.

THE AXIS OF THE STREAM

From within the Straits the axis of the Gulf Stream runs approximately parallel with the 100-fathom curve as far as Cape Hatteras, a distance of about 800 geographical miles. Since this stretch of coast line sweeps northward in a sharper curve than does the 100-fathom line, the axis lies at varying distances from the shore. Within the

Straits it is about 10 miles off shore; in the bight off the coast of Georgia this distance is about 100 miles; and at Cape Hatteras it is about 35 miles. In Figure 4 the axis is shown as compiled from Coast and Geodetic Survey Charts 1007 and 1001 and Hydrographic Office Chart 1411. On these charts the axis bears the following legends: "approximate axis of maximum strength" (Chart 1001); "approximate location of axis of Gulf Stream" (Chart 1007); "mean position of axis of Gulf Stream" (Chart 1411).

Even with a qualifying phrase directing attention to the fact that it is only approximate, the axis of the Gulf Stream as it appears on a chart tends to convey a sense of definiteness and precision wholly at variance with the observed facts. The channel of the Gulf Stream is so wide and is characterized by so many irregularities that the simple flow postulated can be but the roughest approximation.

Strictly, we should distinguish between the temperature axis and the velocity axis of the Gulf Stream. The earlier systematic observations on the Gulf Stream dealt with the temperature of the water rather than with its motion. Hence the axis was taken to be the line along which the highest temperatures obtained. Later, the axis was taken to mark the line of greatest velocity. Ordinarily it is assumed that the two axes coincide; but this is by no means certain, and only systematic observations over a considerable period can solve this problem.

Lateral Boundaries

Within the Straits the lateral boundaries of the Gulf Stream can be fixed with considerable precision. But when the Stream issues into the sea, how are these boundaries to be determined? On the western side, to be sure, it is not difficult to define limits, since the waters of the Stream differ in color, temperature, salinity, and flow from the inshore coastal waters. But on the east the Antilles Current comes to reënforce the Gulf Stream, so that its waters here merge gradually with the waters of the open Atlantic. In terms of color, temperature, and salinity it would be difficult to define the eastern limits of the Gulf Stream. With regard to direction of flow, however, we may fix the limits to include all the water flowing parallel to the axis. These limits vary with the seasons and with changing conditions of wind and weather. Furthermore, our knowledge of currents in the open sea is not yet sufficient to enable us to fix such limits with precision. Nevertheless, from such charts of the currents of the Atlantic as Schott's[11] and Meyer's[12] we may arrive at some approximately accurate estimate of the lateral extent of the Gulf Stream.

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[11] *Ibid.*, Pl. XV, following p. 144.

[12] H. H. F. Meyer: Die Oberflächenströmungen des Atlantischen Ozeans im Februar, *Veröffentl. Inst. für Meereskunde*, No. 11, 1923, Berlin.

It has generally been taken that the inner edge of the Gulf Stream, from its outfall into the sea to Cape Hatteras, is defined by the 100-fathom curve. But recent observations by the Coast and Geodetic Survey indicate that it lies closer inshore. Systematic current observations made on board Diamond Shoals Light Vessel, which is anchored in 30 fathoms of water off the coast of North Carolina about 14 miles southeast of Cape Hatteras, give an average surface current here of 0.4 knot setting N. 58° E., which proves that along this stretch of the coast the inner edge of the Gulf Stream lies nearer the 20-fathom curve than the 100-fathom curve. Taking the inner limit of the Gulf Stream as far as Cape Hatteras to be defined by the 50-fathom curve, and the outer edge to be defined by a line along which the current is still approximately parallel to the axis of the Gulf Stream, the width of the Stream northward of its outfall is as follows: off Cape Canaveral about 70 miles; off the coast of Georgia after its union with the Antilles Current about 150 miles; off Cape Hatteras about 200 miles.

Conflict with the Labrador Current

The region off Cape Hatteras has been called the "delta" of the Gulf Stream, for here the widespreading current separates into a number of bands. This is most clearly evidenced by the juxtaposition of warm and cold bands of water of varying widths. This feature is also noted below Cape Hatteras but not in so marked a degree.

North of Cape Hatteras the Gulf Stream flows with a velocity averaging a little less than a knot, turning more and more eastward under the combined effects of the deflecting force of the earth's rotation and the eastwardly trending coast line, until the region of the Grand Bank of Newfoundland is reached. Here it comes into conflict with the southerly flowing Labrador Current which carries cold water of relatively low salinity.

The Cold Wall

At an early stage of the investigations it was found that on its western or inner side the Gulf Stream was separated from the coastal waters by a zone of rapidly falling temperature, to which the term "cold wall" was applied. It is most clearly marked north of Cape Hatteras but extends, more or less well defined, from the Straits to the Banks of Newfoundland. The abrupt change in the temperature of the waters separated by the cold wall is frequently very striking. Ward refers to an occasion in 1922 when the U. S. Coast Guard Cutter *Tampa*, which is about 240 feet long, was placed directly across the cold wall, and the temperature of the sea at the bow was found to be 34° while at the stern it was 56°.[13]

[13] R. DeC. Ward: A Cruise with the International Ice Patrol, *Geogr. Rev.*, Vol. 14, 1924, pp. 50-61; reference on p. 54.

In the vicinity of the Banks of Newfoundland the cold wall represents the dividing line between the warm waters of the Gulf Stream and the cold waters of the Labrador Current; and it seemed reasonable to invoke the cold waters of this current in explaining the existence of the cold wall and the relatively low temperatures of the coastal waters to the southward and westward. It was largely on this account that the waters of the Labrador Current were assumed to flow all along the eastern coast of the United States.

Recent observations, however, do not bear out this explanation. Current observations on various light vessels along the Atlantic Coast of the United States made in recent years by the Coast and Geodetic Survey give no evidence of a predominant southerly movement of the water along the coast. From the observations made by the International Ice Patrol, Smith concludes that there is no southwest flow of the Labrador Current across the Great Bank, but that it "turns sharply, between parallels 42 and 43 and meridians 51 and 52, to flow easterly, parallel with the Gulf Stream."[14] In his study of the Gulf of Maine, Bigelow gave careful consideration to this question. His conclusion is that he has "no hesitation, therefore, in definitely asserting that the Labrador Current does not reach, much less skirt, the coast of North America, from Nova Scotia southward, as a regular event."[15]

Several agencies appear to be responsible for the cooler coastal waters along the eastern coast of the United States. In the first place into this area the rivers bring their drainage waters from the land, these waters being for the greater part of the year much colder than the open ocean waters. Another contributory cause is the deflection by the earth's rotation of cold water from the Gulf of St. Lawrence against the American coast. Then, too, the coastal waters are closer to the low winter temperatures of the land and are thus made colder than the open ocean waters. A further cause is found in the winds, which along the coast of the United States are prevailingly from the land. This tends to drive the warmer surface water seaward, its place being taken by the cooler subsurface waters.

The North Atlantic Drift

When we come to a study of the horizontal circulation of the North Atlantic Ocean we find a complex system of interrelated currents, as is evident from a glance at Figure 5. In this figure, which is adapted from Schott, three characteristics of the currents are indicated. The

[14] Edward H. Smith: Oceanographic Summary, in "International Ice Observation and Ice Patrol Service in the North Atlantic Ocean, Season of 1922," *U. S. Coast Guard Bull. No. 10*, Washington, 1923, pp. 93–97; reference on p. 97.

[15] H. B. Bigelow: Physical Oceanography of the Gulf of Maine, *U. S. Bur. of Fisheries, Doc. No. 969*, Washington, 1927, p. 828. See also H. B. Bigelow: Exploration of the Waters of the Gulf of Maine, *Geogr. Rev.*, Vol. 18, 1928, pp. 232–260.

direction of the current at any point is shown by the direction of the arrow at that point; the strength of the current or its velocity is indicated by the width of the arrow; and the stability of the current is indicated by the length of the arrow. The stability of the current at any point is expressed as a percentage and is a measure of the constancy

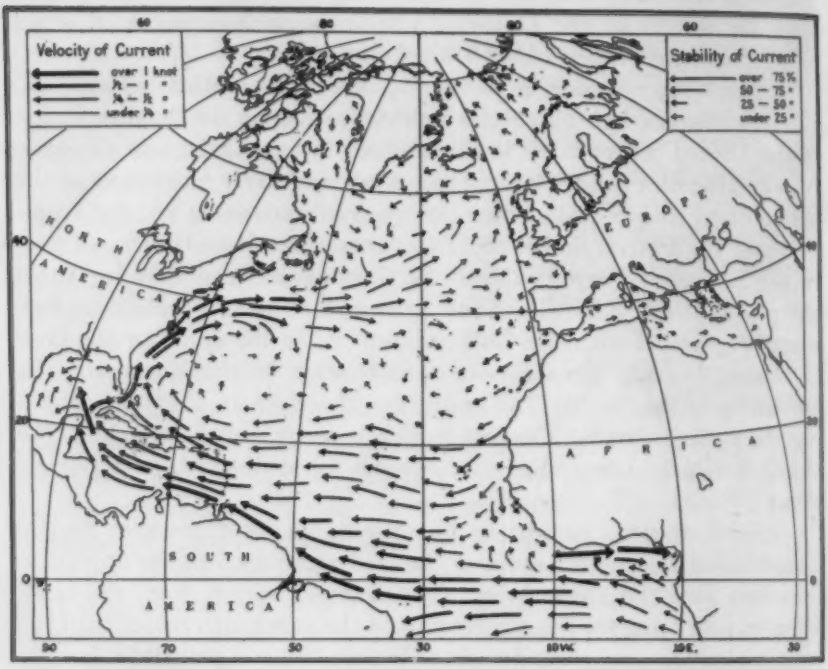

FIG. 5—Surface currents of the North Atlantic Ocean. (After Schott.)

of direction of the current at that point. The derivation of the numerical value of the stability involves technical details[16] which need not detain us here.

In a very real sense the circulation indicated by Figure 5 constitutes a single current system; for a movement of the water at any point implies corresponding movements and return currents at other points, all these movements together forming a system of circulation. However, the large area covered by the North Atlantic Ocean and more particularly the different characteristics of the moving masses of water as regards temperature, salinity, and velocity make it convenient to designate various parts of the system by distinctive names, as for example the North Equatorial Current or Canary Current.

Starting at any given point various circuits may be traced on a current chart. The one which, under the name of Gulf Stream, we have followed from the Straits of Florida as far as the Banks of

[16] Krümmel, *op. cit.*, Vol. 2, p. 441.

Newfoundland may be traced further eastward and northeastward to the coastal waters of northwestern Europe, as shown in Figure 5. Shall this current circuit from the eastern coast of the United States to northwestern Europe be designated by the single name Gulf Stream? Or shall we limit the name Gulf Stream to the stretch from the Straits

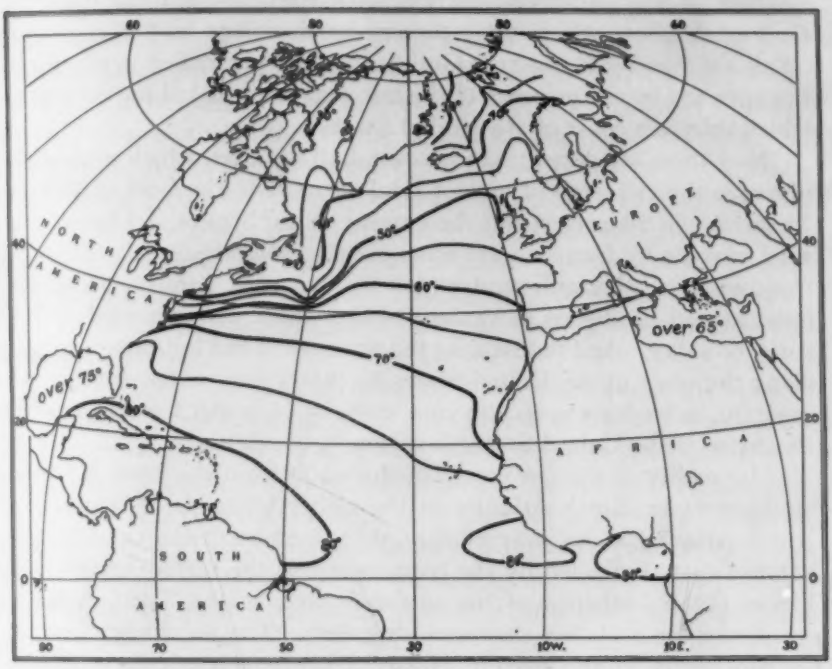

FIG. 6—Isotherms of the surface waters, North Atlantic Ocean. (Adapted from Schott.)

to the Banks of Newfoundland, since in this stretch the characteristics of the current are much the same? If it is the northeasterly transport of warm water across the Atlantic that one has in mind, a single name like Gulf Stream or North Atlantic Current has many advantages. If, however, the causes and details of the movement of the water are being studied, the phenomena are more clearly apprehended by giving the current eastward of the Banks of Newfoundland some such name as Gulf Stream Drift or North Atlantic Drift. It is a slow current, the velocity averaging less than half a knot, and its movement is due in large part to the westerly winds which prevail over this stretch of the ocean.

The validity of the conception underlying the representation of the movement of the waters in the Gulf Stream and in the North Atlantic Drift by current charts like Figure 6 has been assailed in recent years by Dr. E. Le Danois. In a paper published in 1924[17] he elaborates the

[17] E. Le Danois: Étude hydrologique de l'Atlantique-Nord, *Annales Inst. Océanographique*, Vol. 1 (N. S.), 1924, pp. 1–52.

thesis that the movement of the waters of the North Atlantic consists of two currents—a circumpolar current and an equatorial current—and various so-called transgressions, by which name he denominates slow periodic movements of the water of the nature of long-period tidal movements. The Gulf Stream in particular he reduces to a mixture of the equatorial current with the tidal current from the Gulf of Mexico, which tidal current he mentions as being violent. "This tidal current—the true Gulf Stream—is compelled to move into the open sea by the presence of the last waters of the Labrador Current which skirt the coast of the United States" (p. 19).

Now there are data at hand, as we shall see later, which completely disprove the existence of violent tidal currents in the Gulf of Mexico. Moreover, in characterizing the current in the Straits of Florida as a tidal current Le Danois must have in mind something quite different from what is commonly understood by the term, namely, a periodic forward and backward movement of the water with a period of half a day or a day. And in invoking the presence of the Labrador Current along the coast of the United States he surely does not strengthen his case; for, as we have seen, the view that the Labrador Current reaches the coast of the United States is no longer tenable.

The reality of the movement of the water from the lower latitudes of the western North Atlantic to the higher latitudes of the eastern North Atlantic is not only evidenced by a chart of the currents but is also clearly indicated by the temperature of the surface waters. In Figure 6 the isotherms of the surface waters of the North Atlantic are shown for each five degrees Fahrenheit. The northerly sweep of the isotherms in the eastern North Atlantic points clearly to the existence of a current moving easterly and northerly across this oceanic basin.

Causes of the Gulf Stream

Ocean currents may arise from any one or more of a number of causes. Some of these causes reside within the sea itself, others originate without. Differences in level between two regions of an ocean basin, brought about by whatever agencies, will result in a surface current from the higher to the lower level. Differences in density, whether arising from difference in temperature or in salinity or both, will bring about a subsurface current from and a return surface current to the region of greater density. Differences in atmospheric pressure between two regions will, in the same way, bring in their train a subsurface current from and a return surface current to the region of greater pressure. And in the wind we have at once the most obvious and the most familiar of the agencies that bring about ocean currents.

In a current traversing so long a course as that of the Gulf Stream it is plain that all the agencies enumerated above enter as factors.

Clearly, too, the relative importance of the different agencies must vary in different parts of the course. But various problems of an hydrodynamic character must yet be solved before a numerical evaluation of the relative importance of the agencies concerned in the movement of the Gulf Stream is possible.

A century and a half ago Franklin thought that the Gulf Stream "is probably generated by the great accumulation of water on the eastern coast of America between the tropics, by the trade winds which constantly blow there." And in the trade winds, which bring about a westerly flow of the waters in the equatorial regions of the Atlantic Ocean, is still found the primary cause of the Gulf Stream. As appears from Figure 5, the waters of the South Equatorial Current are the first to strike the coast, the greater part being directed northwestward into the Caribbean Sea where they reënforce the flow of the North Equatorial Current. From the Caribbean the combined flow comes into the Gulf of Mexico whence it issues as the Gulf Stream into the Straits of Florida.

Now while the Gulf Stream is traced to the trade winds, the Stream is not a wind or drift current as are the North and South Equatorial Currents. The accumulation of water resulting from the trade winds brings about a gradient current. This means that a higher level of the water must obtain in the Gulf of Mexico than out in the open sea north of the Straits of Florida. Agassiz quotes Hilgard as regarding the Gulf of Mexico "as an immense hydrostatic reservoir rising to the height of more than three feet above the general oceanic level, and from this supply comes the Gulf Stream, which passes out through the Straits . . . the only opening left for its exit."[18] And in a footnote he adds, "By a most careful series of levels, run from Sandy Hook and the mouth of the Mississippi River to St. Louis, it was discovered that the Atlantic Ocean at the first point is forty inches lower than the Gulf of Mexico at the mouth of the Mississippi." In a paper published in 1914 Hepworth states, "As regards the Gulf Stream, and its causation, it was found by the officers of the United States Coast Survey that the Atlantic ocean at Sandy Hook was 3 to 4 feet lower than the waters of the Gulf of Mexico at the mouth of the Mississippi."[19]

It should be remembered that leveling of even the highest precision is subject to instrumental errors which, while very small for moderate distances, may become relatively large between widely separated points. More recent results reduce very much the difference in level between the Gulf of Mexico and the Atlantic and bring to light the fact that this is a highly involved matter. Avers recently studied this question in connection with the broader question of the deviations

[18] Alexander Agassiz: Three Cruises of the United States Coast and Geodetic Survey Steamer "Blake" (2 vols., Boston and New York, 1888), Vol. 1, p. 249.

[19] M. W. Campbell Hepworth: The Gulf Stream, *Geogr. Journ.*, Vol. 44, 1914, pp. 429–452 and 534–553; reference on p. 435.

of local sea level from a level surface.[20] His results, which are based on the best available data, may be summarized as follows. From Galveston, Texas, to Cedar Keys, on the west coast of Florida, the level of the Gulf slopes downward, the difference between the two places being 0.43 foot. The level of the Gulf at Cedar Keys is 0.36 foot higher than the level of the Atlantic Ocean at St. Augustine on the eastern coast of Florida. But from St. Augustine northward there is an upward slope of sea level all along the Atlantic coast of the United States; so that in the vicinity of Sandy Hook sea level is actually 0.62 foot higher than at St. Augustine and but 0.16 foot below the Gulf level at Galveston.

This upward slope of sea level along the Atlantic coast of the United States does not necessarily mean that the Gulf Stream is moving uphill. For the main body of the Gulf Stream is a number of miles off the coast, and there may well be a downward slope of sea level outward from the coast. The question of sea level itself is one complicated by many factors, and the exact determination of the difference in level between the Gulf and the open sea bristles with numerous unsolved problems.

Fluctuations of the Gulf Stream

The Gulf Stream manifestly must be subject to fluctuations as regards location, velocity, and temperature. Heavy winds will not only carry its waters into regions which at other times it does not invade but will also accelerate or retard its velocity. Variations in barometric pressure likewise will bring about fluctuations in the movement of the waters of the Stream. Seasonal variations in temperature in the regions through which it flows will be reflected in somewhat similar seasonal variations in the temperature of its waters. A further cause for its fluctuation is found in the fluctuations of the currents which feed it or which, like the Labrador Current, come into conflict with it.

Fluctuations in the velocity of the Gulf Stream are noted by Pillsbury. He refers to an occasion, while he was at anchor in the Straits of Florida, when the velocity of the current at the surface increased from 3.3 knots to 4.6 knots in less than an hour. He speaks, too, of "a regular *daily variation* in velocity which amounts in some instances to nearly 2½ knots" (p. 546). This regular daily variation he regarded as of the nature of a tidal effect. His observations were later subjected to harmonic analysis by Harris, who found the principal constituent of the tidal current to have a velocity of less than a quarter of a knot.[21]

[20] H. G. Avers: A Study of the Variation of Mean Sea-Level from a Level Surface, *Bull. Natl. Research Council, No. 61 (=Trans. Amer. Geophys. Union, 1927)*, Washington, 1927, pp. 56–58.

[21] R. A. Harris: Manual of Tides, Part V: Currents, Shallow-Water Tides, Meteorological Tides, and Miscellaneous Matters, *U. S. Coast and Geodetic Survey Rept. for the Year Ending June 30, 1907*, Washington, 1907, Appendix 6, pp. 231–545; reference on pp. 411–412.

The tidal current in the Straits of Florida is therefore of negligible velocity, and the fluctuations noted by Pillsbury are undoubtedly irregularities which accompany the flow of water in large masses.

Pillsbury was also of the opinion that, in addition to this so-called regular daily variation and to fluctuations arising from changes in wind and weather, the Gulf Stream within the Straits of Florida was subject to periodic monthly variations in both temperature and velocity which depend on the declination of the moon. The observations are not, however, sufficiently extensive to settle this question definitely. The reality of such variations is still in question, and it would not be at all surprising if further investigation should disprove any such relationship.

In a paper before the American Meteorological Society on "Temperature Variations in the Gulf Stream in the Straits of Florida, 1917–1921,"[22] Hazel V. Miller presented the results of a study of several thousand readings of surface-water temperature made by observers on the Key West-Havana car ferries across the Straits of Florida for the four-year period 1917–1921. The temperature was found to range from a minimum of about 76° in January to about 86° in September, while variations of as much as 4° from week to week under the influence of a strong wind were noted. A comparison of weekly temperatures with winds brought out clearly immediate and persisting effects of the wind as regards both direction and velocity.

From the nature of the agencies concerned, fluctuations from day to day in the flow and temperature of the Gulf Stream may be taken for granted. Seasonal variations likewise are unquestionable, as are smaller fluctuations from year to year. Vilhelm Pettersson studied the temperature data derived from ships' logs, covering the Gulf Stream up to latitude 33° N., for the fourteen-year period 1900–1913. He found that the temperature of the surface waters varies from year to year, generally by less than 1° but sometimes by more than a degree.[23] Whether these yearly variations are, in large or small part, of a periodic nature is at the present time, for lack of sufficient data, an open question.

The difficulties involved in securing systematic observations on the temperature and flow of the Gulf Stream to determine the nature and extent of its fluctuations are obvious. The observations recorded in navigators' log books furnish valuable information, but such observations are not sufficient of themselves. More hopeful is the slowly growing use of sea-water thermographs aboard ships. From the records furnished by these instruments definite information regarding fluctuations in the temperature of the Gulf Stream waters should result.

[22] Abstract in *Bull. Amer. Meteorol. Soc.*, Vol. 7, 1926, pp. 87–88.

[23] V. I. Pettersson: Étude de la statistique hydrographique du Bulletin Atlantique du Conseil International pour l'Exploration de la Mer, *Svenska Hydrogr.-Biol. Komm. Skrifter, Hydrografi* 1 (*N. S.*), 1926, p. 4.

In the light of the preceding considerations the question of whether there has been any permanent change in the course or in the temperature of the Gulf Stream since it has been known to civilized man, may be answered shortly. Manifestly, without extensive observations which would permit comparisons, no categorical answer can be given. But it is clear that any decided change in an ocean current of the magnitude of the Gulf Stream can come only as the result of extensive changes in such features as the bottom of the ocean, the configuration of the coast line, or the prevailing winds. Since no such extensive changes appear to have taken place, it is highly improbable that any decided change in the course of the Gulf Stream has occurred since it has become known.

Climatic Effects

A host of problems lie covered by the question of the climatic effects of the Gulf Stream. That its warm waters have an ameliorating effect on the lands near which they flow is a strongly held opinion; and now and again schemes are seriously proposed to change the course of the Stream with a view to moderating the winter climate of our northeastern states.

A moment's consideration is sufficient to show that the direct influence of the Gulf Stream on the climate of the greater part of the eastern coast of the United States is altogether negligible. For, aside from latitude, our climate depends mostly on the direction from which the winds come and the force with which they blow. In winter the winds along the northeastern coast of the United States are prevailingly from the northwest, that is from the land. Hence the warm waters of the Gulf Stream lying several hundred miles to the leeward can in no way moderate our winter climate.

These considerations are sufficient also to prove the absurdity of the proposals for changing the course of the Gulf Stream in the interests of a more equable climate. Furthermore, the forces that give rise to the Gulf Stream are of such magnitude that they are not yet amenable to control by man. But even if the Gulf Stream could be brought nearer our shores the climate could be moderated only if the winter winds could be made to blow from the south or the southeast.

Indeed, there are good reasons for believing that if the Gulf Stream were to shift closer to the coast the climate of our northeastern states would become more extreme rather than moderated—colder and more stormy in winter, hotter and more humid in summer. For, with warm air near the coast in winter, a greater flow of air from the northwest would result, bringing severer storms and colder weather. In summer, the winds along the coast are more or less sea breezes, bringing the cooler air from the sea to moderate the heat. With warmer air nearer

shore, the sea breezes would become weaker and less frequent, thus giving wider scope for the hot land winds.

While the moderating effect of the Gulf Stream on the climate of North America is negligible, there is no question as to its beneficent effects on the climate of northwestern Europe. Scandinavia and southeastern Greenland face each other across the intervening waters of the Atlantic Ocean along the same parallels of latitude. Contrast the populous and prosperous lands of the one with the bleak and inhospitable shores of the other!

It is to be observed that the tempering influence of the Gulf Stream on the climate of northwestern Europe is effected through the agency of winds. In winter the winds are there prevailingly from the southwest. Blowing over the relatively warm water which the Gulf Stream (using the term as embracing also the North Atlantic Drift) has brought to the northeastern rim of the Atlantic, they carry warm air onto the coast. It is through this mechanism that the heat exchange in winter between the Gulf Stream and the air of northwestern Europe takes place.

How great the influence of the Gulf Stream on the climate of northwestern Europe is, becomes evident from the fact that the average temperature for the month of January in northern Norway is about 45° above the January temperature normal for that latitude.[24] Hammerfest, on the north coast of Norway in latitude 70° 40′ N., well within the Arctic Circle, is an important harbor and sea-fishing center during the winter, while the port of Riga, about 800 miles farther south, is obstructed by ice throughout the season.

Since the climate of northwestern Europe is so strongly influenced by the Gulf Stream, should not fluctuations in the latter find reflection in changes in the climatic conditions of this region? At first glance the differences in temperature of the Gulf Stream from year to year—something like one degree—might appear insignificant in such a connection. But the fact is not to be overlooked that the capacity of water for heat is so great that when a given volume of water gives off the heat represented by a fall of one degree in temperature, a mass of air more than 3000 times that volume will have its temperature raised one degree.

A direct attack on this problem is difficult because of the lack of systematic observations on the temperature and flow of the Gulf Stream. Otto Pettersson studied the temperature variations of the water at several places along the Norwegian coast and found that these variations were reflected by corresponding variations in various climatic phenomena.[25] The problem clearly is a complicated one involving the

[24] J. W. Sandström: Über den Einfluss des Golfstromes auf die Winter-temperatur in Europa, *Meteorol. Zeitschr.*, Vol. 43, 1926, pp. 401–411; reference on p. 401.

[25] Otto Pettersson: Über die Beziehungen zwischen hydrographischen und meteorologischen Phänomenen, *Meteorol. Zeitschr.*, Vol. 13, 1896, pp. 285–318.

question of the mutual interaction of ocean and atmosphere. A considerable literature has grown up around this, which is summarized by Helland-Hansen and Nansen.[26]

One phase of this problem links with the question of long-range weather forecasts. It is a long circuit that is traversed by the Gulf Stream from its place of origin in the subtropical regions to the coasts of northwestern Europe. How long a period intervenes between fluctuations in the Stream and the resultant climatic effects in Europe? This problem, too, cannot yet be attacked directly, because of the lack of systematic observations. Such investigations as have been made show this to be a promising field. Thus Otto Pettersson found that the date when spring plowing could commence near Upsala depended on the temperature of the water of the Atlantic off the coast of Norway about two months previous. Vilhelm Pettersson found that the summer temperature of the water in the region between Newfoundland and Ireland gave an indication of the rainfall in Ireland and Great Britain in the following year.

Obviously the problem of unraveling the relationship between changes in the Gulf Stream and weather conditions several months hence is not a simple one. Climatic conditions in any given region of the North Atlantic result from the interplay of a number of factors. Similarly, the temperature of the Stream at any given time is brought about by the interaction of a number of agencies. Nevertheless it appears that in the study of the fluctuations of the Gulf Stream lies the possibility of long-range weather forecasts for a considerable part of Europe.

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[26] Björn Helland-Hansen and Fridtjof Nansen: Temperature Variations in the North Atlantic Ocean and in the Atmosphere, *Smithsonian Misc. Colls.*, Vol. 70, No. 4, Washington, 1920, pp. 26–51.

NEW ENGLAND

John K. Wright
American Geographical Society of New York

FROM the lonely summit of Monadnock Mountain on a clear autumn day one can look over a large part of southern New England. Eastward, ships off Portsmouth may be seen with a glass; westward, Greylock, about seven miles from the New York line, appears not very distant. Around the base of the mountain spreads a hill country typical of the New England upland, with its varied patchwork of woodland, field, and pasture, punctuated by isolated farmhouses and church spires. Second-growth woodland, however, predominates, covering hillsides, filling valleys, suggesting farms gone back to forest and farm folk departed west or to the cities. A keen eye will also find here and there a group of camps beside a pond, a hotel, a rehabilitated farmhouse, and perhaps will see in them evidence of a gradual but mighty transformation: the coming of the summer people to supply—to the remnant farm and village folk—not only the sources of a prosperity that cannot be wrested from a rocky soil but ideals and ambitions alien to those of their forebears.

Far to the south and east smoky blurs rising over the hills from factory chimneys in Fitchburg and Lowell remind one of another New England—the New England of industry and cities. Yet more distant, Boston's only skyscraper, the tower of the Custom House, may be faintly discerned. Possibly one may think of this as a symbol of the seaport metropolis and of what sea trade has meant in New England's development. On the opposite horizon the long, dark ridge of the Berkshires looms as a barrier that has done much to prevent the seaport metropolis of New England from becoming the main gateway to the United States, a natural frontier that, continued north in Lake Champlain, separates New England in more than a physiographic sense from the rest of the United States and contributes toward its regional and historical unity.

Finally, the climber will look north. Sharply etched against the sky are the White Mountains, pale with freshly fallen snow. Here he will see another symbol, that of the long and early winter, which no less than the nature of the ground has had a part in molding New England character. Possibly, too, he will think of the White Mountains as the outpost of a tract of wilderness stretching far to the northeast across Maine, the forested "wild lands" whose exploitation has created a distinctive type of people and of enterprise.

In the words of Benton MacKaye,[1] Monadnock stands forth as "the emblem of a unified homeland . . . the lofty pivot of an indigenous region and culture, of a sample pattern of the American quiltwork—a point from which to see 'a land' and to contemplate the problems that confront it." From Monadnock's summit the thoughtful observer may sense in the serene expanse of country spread below him something of the complexity, the accelerating pace, and the almost irresistible force of social and economic changes in progress.

Rural and Urban Problems

Although for more than a century population has been drifting to the cities, of late the problems of rural life and rural depopulation have assumed new aspects. The fringes of the cities with their suburban satellites are creeping outward into the countryside. Encircling each metropolis are zones over which there ebb and flow daily tides of office workers and weekly tides of urban tourists. Since the coming of the automobile these zones have expanded far beyond their former margins, and outside of them there is hardly a rural township in all New England not reached by the seasonal tide of vacationists. Few, if any, parts of New England are left where a man from the city excites the slightest degree of curiosity. This was hardly the case a generation ago. Not only does the urban population overflow the country in periodic migrations, but outward from the cities there is a constant radiation of influences carried by newspaper, by magazine, and through the air, by salesman and reformer, and by the return of farm folks from frequent visits to "town," visits unthought of before the days of the automobile. Contact with city folk and exposure to the rays of urban influence are changing the whole complexion of rural life.

People do not leave the farms for the sole reason that they hope to earn more for less work in the cities or for the sole reason that a rising standard of living makes them long for material comforts denied their ancestors. The toil and hardships of farm life have been lessened and may be further lessened by measures leading to greater material gain from the land; and yet the power of these measures to breed contentment may be wholly neutralized by the hypnotism that the city exerts over the hopes and ambitions of the farmer and his growing sons and daughters. As farm folk become more urban-minded new social concepts spread among them, and their desire to associate more freely with their kind grows more deeply rooted. It is conceivable that automobiles, telephones, and radios increase and do not diminish this desire. We must look beyond questions of dol-

[1] Benton MacKaye: The New Exploration: A Philosophy of Regional Planning, New York, 1928, p. 48. In this stimulating volume a philosophy of regional planning is set forth with special reference to New England.

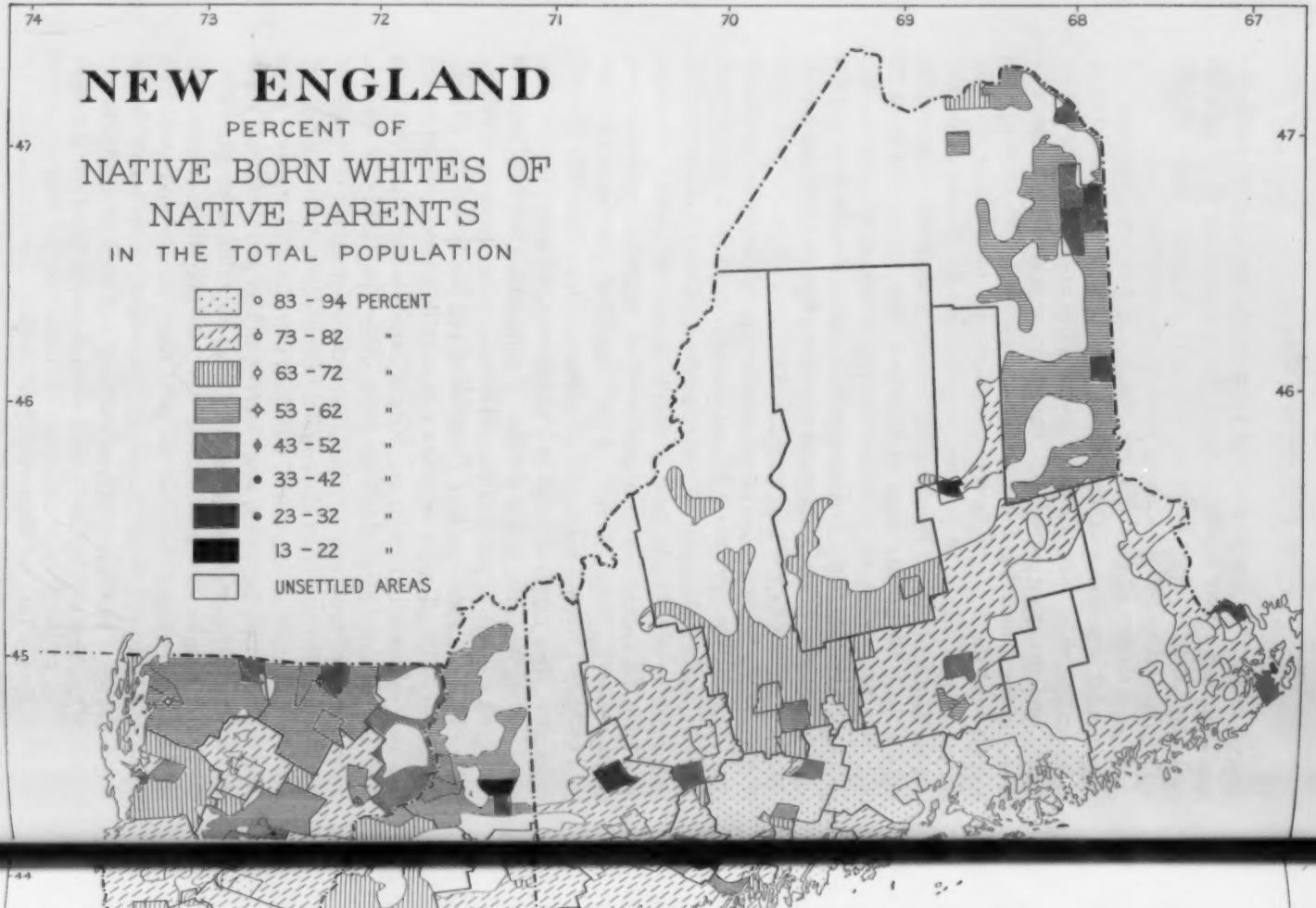
lars and cents if we are to find the roots of the problem of rural depopulation and a way leading toward the regeneration of an agricultural population that will enjoy not only economic stability but intellectual and spiritual harmony with its environment.

These problems of rural life are complex and obscure enough, but every candid observer will also admit that there are manufacturing towns and cities in New England where all is not well. The closed factory and decaying wharf tell stories as weighted with meaning as that of the crumbling cellar hole in the pasture. We cannot blink the fact that some of the larger manufacturing towns have actually lost population. This, to be sure, is symptomatic of conditions that may be local and, where they prevail, wholly temporary. The textile business may be on the road to recovery, more industries may be coming to New England than are leaving it. Yet, whether or not pessimists have painted too dark a picture, all will agree that the urban communities of New England are facing grave problems whose solution must not be too long postponed.

Some of the problems are common to urban communities the world over; others grow out of conditions peculiar to New England; still others are local. Questions of overcrowding, of traffic congestion, of inadequate terminal and market facilities, and of power resources may often be solved by measures of local material improvement. Other difficulties originate from the geographical and economic relations of New England to the rest of the country: from the circumstance that New England is off in a corner of the United States, relatively remote from the trunk streams of commerce that flow between the greater centers of production and consumption; from competition of New England factories with factories of the South and the Middle West; from railroad rates that are unfavorable or thought to be so; from regional peculiarities in methods of business and administration that differentiate New England from other parts of the nation. There are also problems arising from the diversified composition of the population and from the conflict of traditions, institutions, and loyalties that springs out of the mingling of races and creeds. Even when factory doors are open, wage envelopes big, and dividends regular, the benefits of material prosperity may be nullified by the tightening of class lines, the crystallizing of racial prejudices, the maladjustment of established institutions to ideals, customs, and ambitions in flux. Under cover of prosperity, moreover, destructive forces may begin their work and, unless watched and deflected, ultimately gain such momentum that no human wisdom can repair their damage.

Search for Solutions

Why point out the obvious? Everybody who knows New England knows that its problems are complex and difficult. The last


NEW ENGLAND
PERCENT OF
NATIVE BORN WHITES OF
NATIVE PARENTS
IN THE TOTAL POPULATION
83 - 94 PERCENT
73 - 82 "
63 - 72 "
53 - 62 "
43 - 52 "
33 - 42 "
23 - 32 "
13 - 22 "
UNSETTLED AREAS
74
73
72
71
70
69
68
67
47
46
45
44

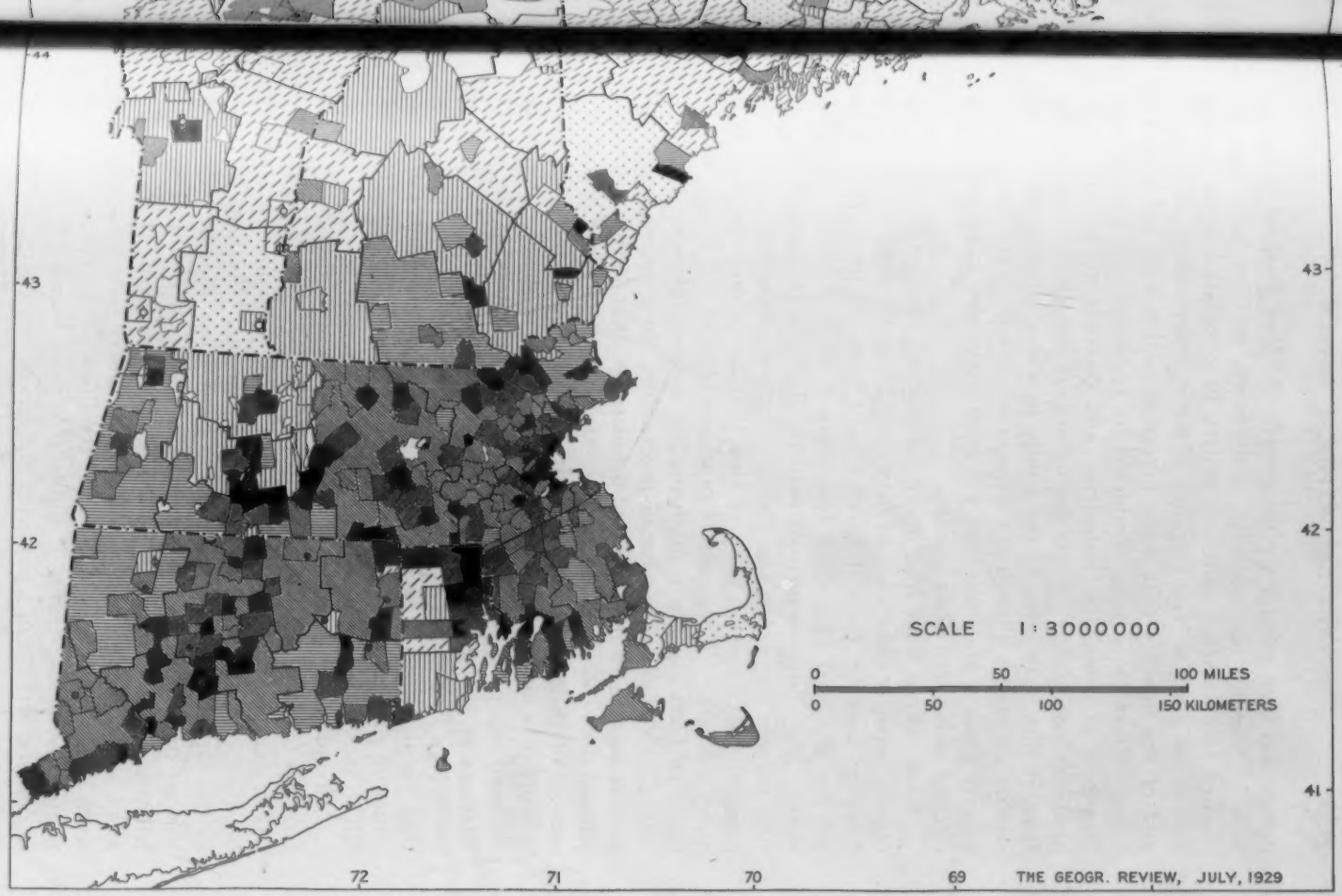


FIG. 1—On this map the lighter the ruled or dotted areas, the more purely "Yankee" is the population (according to the census of 1920). The percentages have been plotted for the smallest areas (wards of cities excepted) for which it is possible to calculate them from the U. S. census reports. See p. 494.

decade has been notable for the growth of "New England consciousness." Committees, councils, conferences, surveys have been organized and countless editorials written to stimulate a larger conception of the unity of New England, of the interdependence of its parts, and of the benefits that more favorable nation-wide publicity will bring. Research is being conducted by state and city governments, chambers of commerce, industries, and corporations as well as by academic institutions. Facts and figures are being sought for tangible benefits they may bring to the groups in whose interests the various studies are made—though not infrequently the facts and figures most eagerly gleaned are those that will seem impressive in an advertising circular or inspired news column.

Even where something more substantial than publicity is the object, however conscientious may have been the quest for data and however honestly these data may have been set forth, research as yet has disclosed only small fragments of all that should be understood. Most business men are realists. To them problems of population become less acute and finally disappear altogether as material prosperity increases—a point of view that has colored the thought of many scholars. "Constructive programs of relief," it is felt, must be based on facts capable of mathematical demonstration or its equivalent; above all else they must be practicable. So intensive has specialization become in industry and scholarship, that business man and scholar alike too often fear to allow their minds to range beyond the spheres of their immediate specialty. This is all to the good when it leads to sound conclusions regarding points of detail. It is to be deplored when, as too often, it produces blindness to the mutual relations of the multitude of details constituting the sum total of life in New England or in any one of the larger economic communities that together form New England. Where such blindness exists constructive programs are merely palliative; they allay symptoms but fail to attack the disease.

An agricultural expert is tempted to believe that most of the farmer's troubles will evaporate with the introduction of better methods of raising crops and tending live stock, with more businesslike bookkeeping, and with coöperative marketing. As long, however, as the farmer cannot command the hired labor that he requires at harvest time, as long as he is aware that his children are not receiving education of the standard he would wish for them, as long as his adult sons, following the lure of the city, leave him to face the farm work single-handed, as long as the condition of the country roads in winter and spring makes it difficult or even impossible for him to obtain the services of a physician in times of emergency, as long as he craves higher religious satisfactions than a moribund village church can give him, his feeling of disquietude and discontent will persist.

In higher wages, in education and Americanization, in model tenements and garden cities and parks the mill owner, the social reformer, and the city planner each sees solutions of the problem of urban life; but no one of these is a panacea for all ills.

When competent modern physicians undertake to cure a complicated and difficult case they first examine into all possible causes of disease or disability. Special apparatus, technical skill, and highly specialized knowledge are essential for many of their tests. The diagnosis, however, will not be complete until the interaction of the different conditions disclosed by the special tests are weighed and balanced and the condition of the organism considered as a whole. Diagnosis that is both thorough and comprehensive is needed regarding the maladjustments in the body politic of New England. The various separate factors—geographical, economic, social, historical—that combine to frustrate the efforts and hopes of large groups of people must be analyzed in detail. For such analyses the natural and social sciences offer developed techniques. Fully as important, however, is the completion of the diagnosis through the correlation of the results of each analysis. The relative importance of the various possible causes of maladjustments in the body politic must be estimated and the milieu viewed as a unit. Then only can we begin to think seriously about cures.

American Geographical Society's Study

It is an encouraging sign that a few scholars and leaders who have New England's welfare at heart see the situation in this light. Some of the papers read last December before the New England Research Council on Food Supply and Marketing give evidence of a vision transcending the limits within which the specialist is tempted to confine himself. To help pave the way for those who will seek and find solutions of New England's problems the American Geographical Society is making a coöperative study of the population in its geographical aspects. Far too large to be envisaged as a whole, New England will be broken into its parts and examined region by region. After the regional analysis has been completed, the picture will have to be put together again and studies made of those super-problems that overlie the boundaries of the regions and reach beyond the borders of New England as a whole. Particular attention throughout will be given to problems that spring from the relations of man to the natural elements of topography, rock structure, soil, and climate.

It is proposed thus to study New England region by region. First, however, we must mark off the boundaries of the regions. We must decide which regions first demand intensive examination and what distinctive problems are presented within each. We must determine

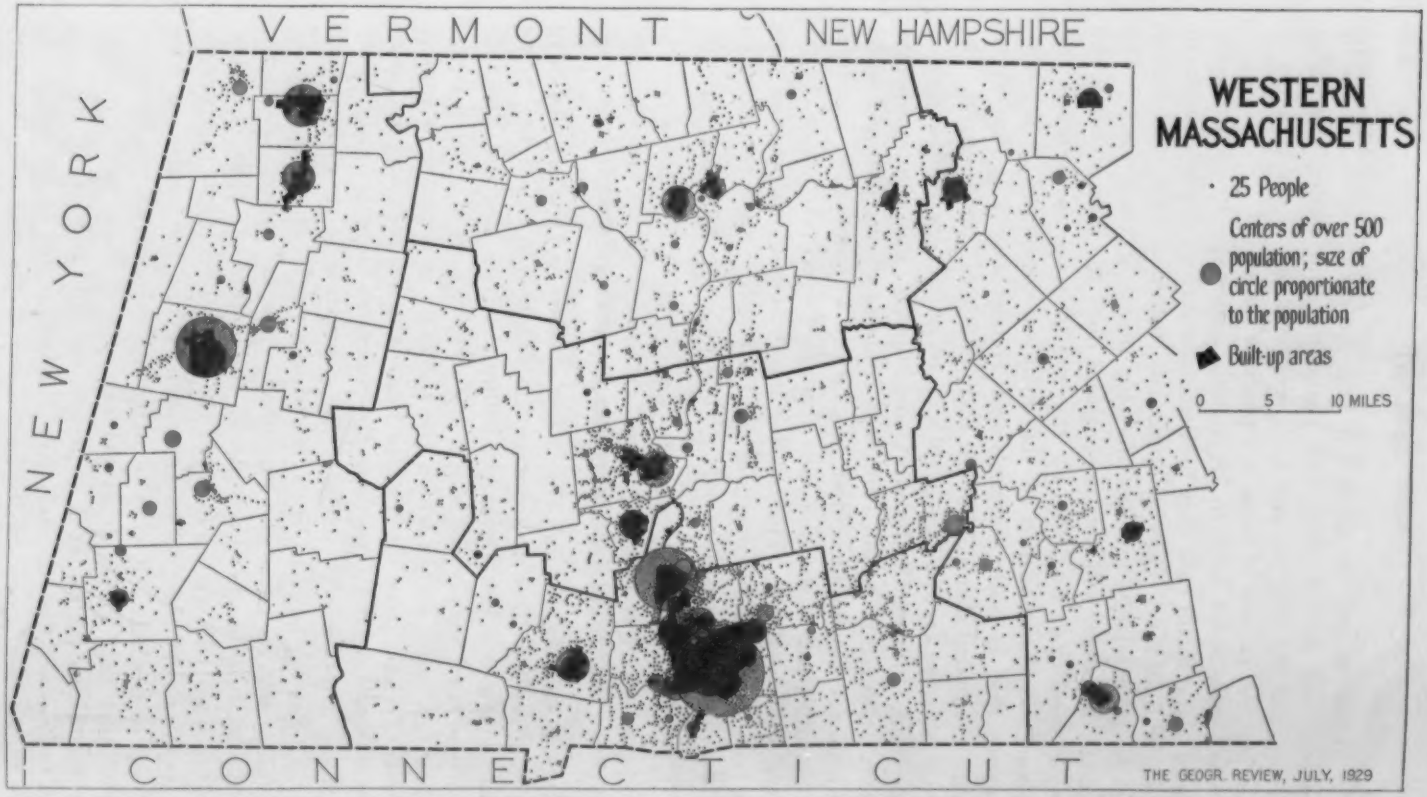


FIG. 2—The distribution of population in western Massachusetts. The population of each town as given in the Massachusetts census of 1925 has been distributed on the basis of a critical study of the topography and "culture" as shown on the U. S. Geological Survey sheets. Diameters of circles indicate approximate populations as follows: 0.8 millimeter = 500; 1.2 m. = 1000; 2.5 m. = 5000; 3.6 m. = 10,000; 5.6 m. = 25,000; 8 m. = 50,000; 11.6 m. = 100,000. See p. 493.

what methods in field and library are best adapted to disclose essential facts. We must survey existing maps, statistics, and reports and find out how reliable they are and how they may be supplemented in the field. We must study the methods of analyzing these data and of presenting the results of research that seem best suited to the peculiar circumstances of New England.

As a means to an end, therefore, during the initial stage of the work and coincidently with it, a reconnaissance will be made covering the whole of New England. Some results of the reconnoitering that has already been done are presented in the Appendix to this paper. Though New England-wide, this reconnaissance differs in purpose from that of the ultimate synthetic studies of New England's super-regional problems contemplated after the detailed regional studies have been completed. Essentially descriptive, bibliographic, experimental, the reconnaissance will aim to define problems rather than solve them. It will show the country through which trails of intensive study may best be followed and, in a general way, whither these trails may be expected to lead. Like a mountain outlook, it will spread below us a broad expanse of landscape before we descend into the lowlands where men live and strive.

APPENDIX

Documentary Studies and Documentary Survey

The libraries of New England contain an immense and ever increasing quantity of data waiting to be given critical expression in geographical terms. The documents from which these data may be gleaned take the form primarily of published and manuscript maps, statistics, and miscellaneous reports relating to routine work and to special investigations carried out by departments of the federal and state governments. Although in some instances they have been consulted in geographical studies—particularly by graduate students in preparing dissertations—no systematic survey of them has been undertaken with a view to their use as sources of geographical information. The Society is making such a survey an important part of its program, the purpose being not only to find material but to discover gaps that preclude the possibility of investigation along particular lines or that can only be filled through intensive studies in the field.

The accompanying maps[3] illustrate some of the preliminary results of this survey. They show the extent to which topographic and soil mapping has been carried, the areas for which certain recent statistics are available, and types of map which may be constructed on the basis of available statistics.

Topographic Maps

The most important topographic maps of New England are, of course, the sheets of the U. S. Geological Survey on a scale of 1:62,500, or approximately one inch to a mile (Fig. 3), supplemented by the coast charts and the U. S. Soil Survey sheets. For cultural features alone, some of the later Soil Survey maps (Fig. 3, inset) are more nearly up-to-date than the U. S. G. S. sheets. Although the Soil Survey in New England has used the topographic sheets as its base, houses, roads, reservoirs,

[3] Compiled by Miss Lois Olson of the staff of the American Geographical Society.

and the built-up parts of cities and villages have been corrected.[3] But, aside from the coast charts, the soil maps, and a very few exceptional maps of small areas (such, for example, as the Appalachian Mountain Club's maps of the White Mountains), the Geological Survey's sheets are the ultimate documentary authority for the topography and "culture" of the larger part of contemporary New England.

The Geological Survey's topographic sheets, however, are not all of the same utility. The earliest surveys in New England were made in the eighties and nineties of the last century, at a time when the Survey's standard was not as high as it has since become. While the earlier sheets have in most cases been issued with minor corrections, they have not been subjected to thoroughgoing revision. Consequently the maps based on the earlier surveys are not only out of date as regards the works of man but are often inaccurate in their representation of water and relief. Some idea of the relative value of the U. S. G. S. sheets on a scale of 1:62,500 may be gained from Figure 3, which shows the dates by decades of the original surveys upon which the different sheets are based. This key map also distinguishes the sheets upon which house dots are indicated in rural areas and upon which woodland[4] is shown. In the earlier editions of many of the sheets for parts of southern New England no town boundaries were represented, but these have been added on later editions.

As will be seen from Figure 3, there are large tracts in the three northern New England states that have not as yet been mapped. These tracts are confined for the most part to forested and other sparsely populated country. For such areas the best one can do is to turn to the county and town maps published commercially during the last half of the nineteenth century.[5] Drawn on scales of one inch to the mile (1:63,360) or slightly larger, these maps show mountains and hills sketchily by hachures. Their primary value, however, lies in their representation of "culture"—buildings, roads, farmhouses, sawmills, gristmills, schools, churches, etc. The names of the mills, schools, churches, and of the owners of property are also indicated, and similar data are supplied for villages and cities on inset plans and special maps of larger scale.

Besides these published maps, there are preserved in the collections of the state historical societies as well as in libraries and archives many manuscript town maps of early date. By enactment of the General Court the Massachusetts towns were required in 1794 and again in 1830 to furnish maps of their territory for use in the compilation of maps of the whole state. There is a file of these town maps, nearly complete, in the State Archives at Boston. Some of the surveys were carried out by professional surveyors and were both accurate and detailed, the resulting maps showing not only the town boundaries, roads, and principal bodies of water but also the location of forests and buildings. For other towns, however, the work was done by inexperienced men, and the results were of inferior quality.

Index Map to Census Data

In drawing maps on the basis of available statistics showing for all New England the distribution of the various facts of population, agriculture, industry, social life, etc., technical problems arise. Some of these are peculiar to New England and spring from the character of the existing statistics and the manner in which they are presented.

[3] W. J. Latimer: General Methods Used in Mapping Soils in Massachusetts, and Some of the Problems, *Rept. Fifth Annual Meeting of the American Soil Survey Association, Held at Chicago, Ill. November 20 and 21, 1924*, Bull. 6, Vol. 1, Ames, Ia., 1925, pp. 33–37.

[4] A map of Connecticut (1:125,000) published in 1893 by the U. S. G. S. in coöperation with the State of Connecticut shows wooded areas. The U. S. G. S. has also issued recently ten advance sheets (1:24,000) based on aerial photographs taken in 1928 and covering part of the Connecticut Valley in Connecticut. These show roads, wood lots, and fences but not buildings.

[5] Reference to some but not all of these maps will be found in P. L. Phillips: A List of Maps of America, 2 vols., Washington, 1901; *idem*: A List of Geographical Atlases in the Library of Congress, 4 vols., Washington, 1909–1920.

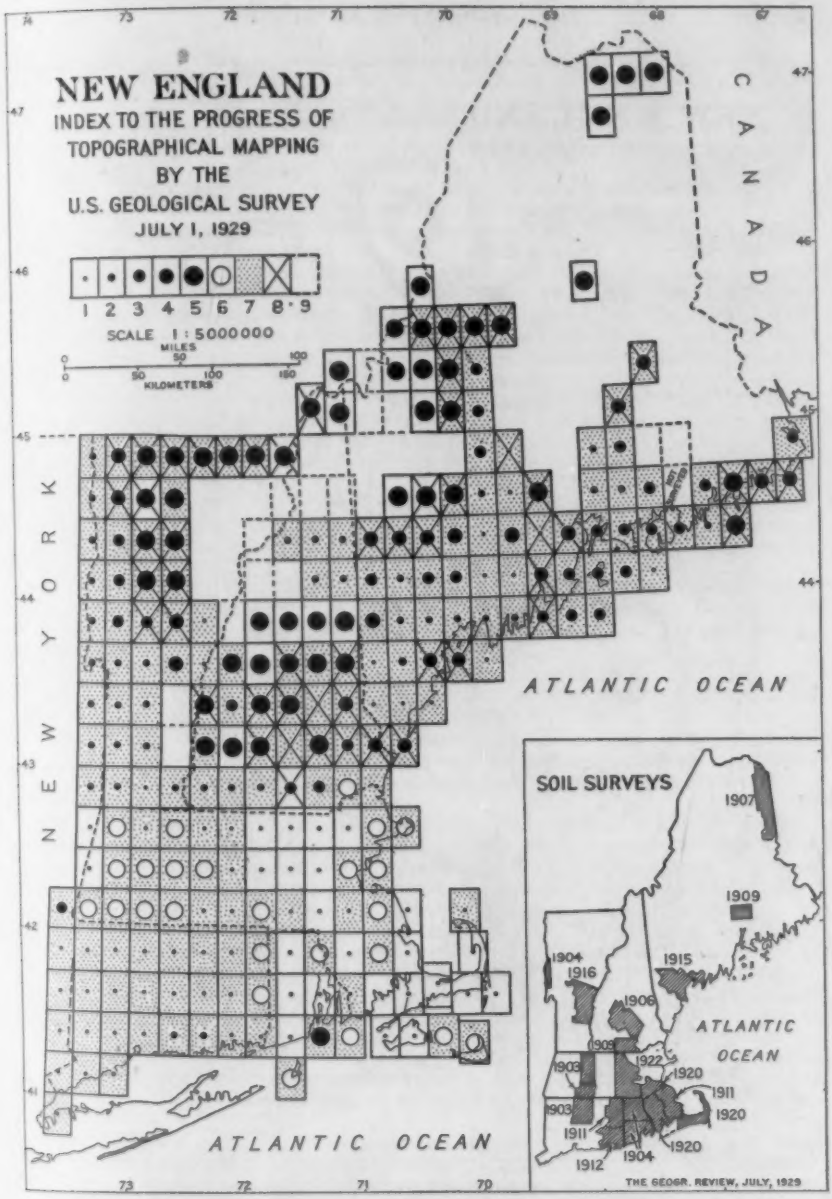


FIG. 3—Maps showing progress in New England of topographical mapping by the U. S. Geological Survey and of soil surveys by the U. S. Department of Agriculture, Bureau of Soils. Explanation: 1–8, topographical sheets (1:62,500) published or advance sheets (1:48,000) issued. 1, surveyed before 1890; 2, surveyed 1890–1899; 3, surveyed 1900–1909; 4, surveyed 1910–1919; 5, surveyed since 1919; 6, surveyed before 1890, revised sheets published 1910–1919; 7, houses shown in rural areas; 8, woodland shown (see also footnote 4, p. 488); 9, surveys completed or proposed, but sheets not yet issued. Scale of inset approximately 1 : 13,000,000.

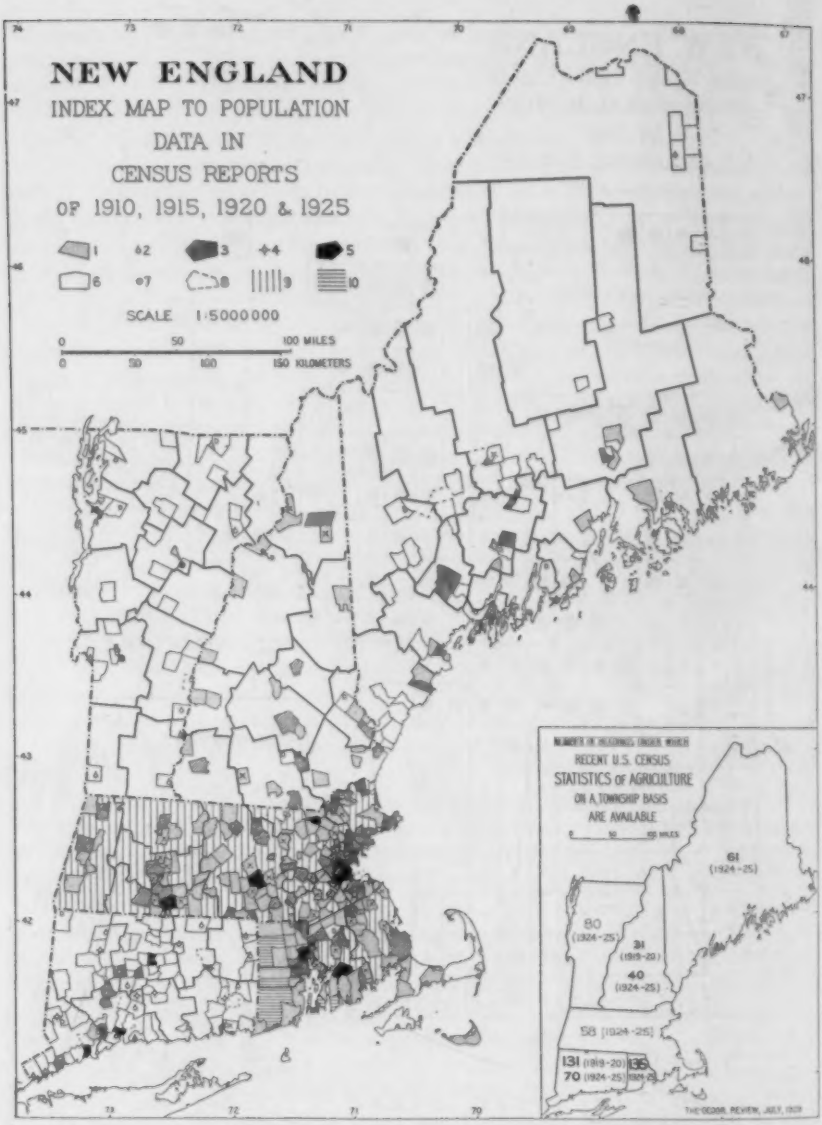

NEW ENGLAND
INDEX MAP TO POPULATION DATA IN CENSUS REPORTS OF 1910, 1915, 1920 & 1925
1 2 3 4 5
6 7 8 9 10
SCALE 1:5000000
0 50 100 MILES
0 50 100 150 KILOMETERS
RECENT U.S. CENSUS STATISTICS OF AGRICULTURE ON A TOWNSHIP BASIS ARE AVAILABLE
61 (1924-25)
80 (1924-25)
21 (1915-20)
40 (1924-25)
58 (1924-25)
131 (1919-20)
135
70 (1924-25)

FIG. 4—Index maps to recent population and agricultural statistics by towns in New England.

EXPLANATION OF FIGURE 4

Figure 4 with the inset differentiates the areas in New England for which there have been tabulated by *cities, towns, and lesser administrative areas* federal and state census statistics for the last twenty years.

Blank areas (except those outlined by Symbols 6 and 8) are areas included in towns having less than 2500 inhabitants in 1910 and 1920. For such towns no federal or state census statistics are available other than the figures for the total population and certain figures for agriculture (see explanation of inset map, below).

Symbols 1, 3, 5, and 6 represent towns and cities, and *Symbols 2, 4, and 7* represent incorporated places not coextensive with the townships within which they lie, for which federal census data on the composition and characteristics of the

population are given either in one or in both censuses of 1910 and 1920. *Symbols 9 and 10* represent areas for which state, but not federal, census statistics are available for composition and characteristics of the population on a township basis.

Symbols 1 and 2. All these places had between 2500 and 10,000 population in both 1910 and 1920, except those marked X, which had less than 2500 in 1910 but between 2500 and 10,000 in 1920. Statistical data on the "composition and characteristics" of the population are furnished in the federal census reports for 1920 for all these places, and in the reports for 1910 as well for all those not marked X. These data are presented under headings of Color or Race, Nativity, and Sex; Illiteracy; School Age and Attendance.

Symbols 3 and 4. All these places had in 1910 and 1920 a population between 10,000 and 100,000, except those marked X, which had a population of less than 10,000 in 1910. For all these places all the data on the composition and characteristics of the population mentioned above are presented in the federal census reports for both 1910 and 1920. For the places not marked X both reports, and for the places so marked the report of 1920 only, present, in addition, more detailed statistics. For example, the foreign-born population is analyzed according to the country of origin, the population is classified into additional age groups, and a variety of other totals and percentages are furnished that are not provided for places of smaller size. There are also certain material differences between the categories of the censuses of 1910 and 1920.

Symbol 5. Cities having in 1910 and 1920 a population of over 100,000, unless marked X, in which case the population was less than 100,000 in 1910. More complete statistics are furnished for cities of more than 100,000 inhabitants than for those of less than 100,000.

Symbols 6 and 7. For these places data on the composition and the characteristics of the population are given in the report of 1910 *but not in 1920.* They all had a population of over 2500 in 1910, but those marked D had declined to less than 2500 by 1920.

Symbol 8. Towns having more than 2500 population in 1920 but less than 2500 in 1910; for these places no data whatever on the composition and characteristics of the population are given in either census report.

Symbol 9. Areas for which the Massachusetts state census of 1915, but not the federal census reports, gives by towns data on the composition and characteristics of the population. The Massachusetts state census of 1925 tabulates merely the total population by towns.

Symbol 10. Areas for which the unpublished Rhode Island census of 1925 and the published Rhode Island census of 1915, but not the federal census reports, give by towns data on the composition and characteristics of the population. Through the courtesy of Mr. E. L. Byers, Commissioner of Labor, the American Geographical Society has obtained a photostatic copy of the Rhode Island census of 1925.

Census statistics of manufactures. Federal censuses of manufactures were taken in connection with the Thirteenth and Fourteenth Censuses of the United States in 1909 and 1919, and also in 1914, 1921, 1923, 1925, and 1927. In the reports for 1909, 1914, 1919, and 1925 for all cities and for certain towns of over 10,000 inhabitants statistics are presented relating to the number of establishments, persons employed, primary horse power, expenses, capital, value of product, value added by manufacture. In the reports for 1909, 1914, and 1919 more complete details are given for places of over 50,000 inhabitants and in the report for 1925 for places of over 100,000. The reports for 1921 and 1923 present statistics by cities for cities of over 100,000 only.

The towns and cities for which these data are given in the reports of 1909, 1914, 1919, and 1925 are those indicated by Symbols 3, 4, and 5 on Figure 2, with, however, the following exceptions: *Maine:* Bath, 1919 and 1925 only; Sanford, 1914; *Massachusetts:* Amesbury, Dedham, Milford, Natick, West Springfield, and Winchester, 1914 and subsequent years only; North Attleborough, 1914 only; Belmont, Braintree, Danvers, Easthampton, Norwood, and Saugus, 1919 and 1925 only; Northbridge, 1919 only; Watertown, not given for 1925; *Connecticut:* Bristol and Norwalk, 1914 and subsequent years only; Derby, 1919 and 1925 only; *Rhode Island:* Lincoln, 1914 only; Bristol and West Warwick, 1919 and 1925 only; Cumberland and Warwick, not given for 1925.

Inset map. This indicates the number of headings under which recent agricultural census statistics have been tabulated by towns, together with the dates to which these statistics apply. The figures for Massachusetts and Vermont are given in broken lines because the statistics were not available in published form when this paper went to press. Through the courtesy of Mr. C. D. Stevens of the New England Crop Reporting Service the American Geographical Society has obtained.

The statistical output of the states is far from uniform as regards either subject matter or methods of tabulation, and even the federal census itself has not always been entirely consistent in its treatment of the different New England states. Definite bounds are thus set beyond which the cartographer cannot go. Not only is the number of distributions for which figures are to be had strictly limited but the optimum cartographic precision that may be attained depends on the size and distribution of the unit areas to which each figure applies. Obviously a better map can be drawn on the basis of statistics by cities and towns (in the New England sense of "township") than by counties, a better map if the basic figures are given for all towns and cities than if they are given for only a few.

Figure 4 may serve as a key to the U. S. decennial censuses of 1910 and 1920, the U. S. Census of Agriculture of 1925, the U. S. censuses of manufactures of 1909, 1914, 1919, 1921, 1923, and 1925, and to the Rhode Island and Massachusetts state censuses of 1915 and 1925. County boundaries are shown, together with the relative number of statistical data provided in these reports for the various towns and cities of New England. For the towns and cities represented by the darker symbols more statistical material is to be had than for the ones shown by lighter symbols. For the areas left white the only existing census figures for the last twenty years are the figures for the total population of each town.

This map covers only census statistics. There is, of course, other statistical material available by townships. Vital statistics published by state health departments cover births, marriages, deaths and causes of death; the published reports of state assessors or tax commissioners, beside giving property valuations and tax rates, usually indicate the number of taxable live stock; in the reports of the departments of education there are many figures regarding school attendance, school equipment, and finances. The Market Data Handbook of New England, recently published by the U. S. Department of Commerce as Part III of The Commercial Survey of New England, tabulates by towns statistics covering wealth factors (bank deposits and number of income tax returns), standard of living factors (home tenure, residence telephones, homes using electricity and gas, average new automobile sales, circulation of magazines), and trade factors (wholesale and retail trade outlets). The number of dollars in domestic money orders issued in 1927 is presented for every post office in New England and the amount in money orders paid for every first and second class post office.

As regards areas it may be noted that figures for the Vermont towns are given in acres in Walton's Vermont Register, published annually by The Tuttle Co., Rutland, Vt. For New Hampshire a tabulation was compiled in 1924 by the State Forestry Department and is available in multigraphed form. For Massachusetts the areas of towns are given on pages 82–86 of the Decennial Census of the Commonwealth,

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a photostatic copy of the Massachusetts statistics as tabulated by the Bureau of the Census for the Massachusetts Department of Agriculture. The pertinent statistics for the other states, together with maps drawn from them, will be found in the following publications:

I. G. Davis and C. I. Hendrickson: A Description of Connecticut Agriculture, *Storrs Agric. Exper. Sta. Bull. 127*, Storrs, Conn., March, 1925 (for 1919–1920 figures).

I. G. Davis and J. R. Jacoby: Five Year Trends in Connecticut Agriculture, *Storrs Agric. Exper. Sta. Bull. 146*, Storrs, Conn., November, 1927 (for 1924–1925 figures).

New Hampshire Department of Agriculture, Division of Statistics: Agricultural Census Report of the State of New Hampshire by Towns, July, 1922 (for 1919–1920; for 1924–1925 see work of same title dated April, 1926).

R. B. Corbett: Rhode Island Agriculture, a Statistical Description, *Rhode Island State College Agric. Exper. Sta. Bull. 206*, Kingston, R. I., August, 1926 (for 1924–1925 figures).

C. H. Merchant: Maine Agriculture, a Statistical Presentation, *Maine Agric. Exper. Sta. Bull. 338*, Orono, Me., March, 1927 (for 1924–1925 figures).

1915, and for Rhode Island on pages 59–60 of the Rhode Island Census Report of 1895. For Connecticut a table showing the acreage of each town from the Report of the Connecticut Bureau of Labor Statistics for 1902 is reprinted in Bulletin 127 of the Storrs Agricultural Experiment Station, March, 1925, pp. 124–132. For Maine no corresponding published data are available.

Figure 4 illustrates two very important circumstances that are true (with differences in details) not only of the recent census statistics for New England but of the earlier census statistics as well.

In the first place, it shows that one cannot on the basis of published census figures make maps on which there will be apparent for *every* town in New England any of the interesting and significant totals or ratios which the census reports tabulate for every county and for the larger towns and cities in regard to foreign-born and native population, age groups, naturalization, sex, school attendance, families, dwellings, farms, crops, farm mortgages, manufacturing establishments, etc.

In the second place, Figure 4 and its explanation make it clear that there are, nevertheless, many towns and cities for which the important and significant facts of the type specified in the preceding paragraph *are* given in the census reports and that these places comprise a considerable area and a large proportion of the population, particularly in southern New England.

This leads to a dilemma in the mapping of data from the census statistics. If town and city statistics alone are used there will be large blank spaces on each map; if county statistics alone, the texture of the resulting maps will be too coarse. The New England county is far too large an area in relation to the various natural, economic, or social regions into which New England might be divided to serve as an adequate statistical unit for any but the most generalized type of map. A compromise, however, may be effected by constructing "hybrid" maps based on a combined use of statistical data presented by counties on the one hand and by towns and cities on the other.

"Hybridization," of course, could be avoided by tabulating and plotting from the original census schedules the pertinent data for all towns for which such data are not given in the published reports. For agriculture tabulations have recently been made by towns for all the New England states, as may be seen in the inset map in Figure 4. Such tabulations involve considerable expense; furthermore, owing to the dispersal and disappearance of many of the original census schedules, they probably could not be carried out on a comprehensive scale for all New England except in the case of the 1920 census.

Map of the Distribution of Population in Western Massachusetts

The distribution of population in western Massachusetts is illustrated in Figure 2. Each dot indicates 25 people in rural areas; the built-up parts of villages and cities are shown in black, and the number of inhabitants of centers of over 500 is indicated by circles proportionate in area to the population of each place. The map represents an attempt to plot the Massachusetts state census figures of 1925 for the total population of each town in such a way that a picture of the actual distribution of population within each town is approximated. This involved a critical examination of the topographic sheets of the U. S. Geological Survey, the Soil Survey maps, and certain other maps. Estimates of the population of certain villages given in the atlases of Rand McNally and Cram also served as a guide. The map as it stands is based exclusively on the study of documents and is reproduced merely to illustrate the method. Before a definitive map of this sort for all New England (on the basis of figures to be determined by the Fifteenth U. S. Census) could be published it would be necessary to submit a preliminary draft to such local authorities

as farm agents, school superintendents, or town clerks for criticism of the representation of the towns with which they are acquainted.[6]

Map Showing the Percentage of Native Whites of Native Parents in the Total Population

The great wave of foreign population that flooded New England before the recent restriction of immigration has created social and economic problems of the first magnitude. Where are these problems most likely to become accentuated? Figure 1 may provide a background for studies of this question.

The U. S. census reports for 1910 and 1920 give for counties, cities, and certain towns the number of native whites of native parentage, native whites of foreign or mixed parentage, and foreign-born whites. Figure 1 shows by different symbols the percentages of native whites of native parentage in the total population, *the lighter the tint the higher being the per cent indicated*. This map represents what is probably the highest degree of regional precision attainable in mapping this distribution on the basis of recent published U. S. census statistics. The figures do not permit the construction of a more detailed map showing this particular distribution. The map is of the "hybrid" type discussed above.

The appropriate percentages for 1920 are plotted separately for every city, for every town that had a population of over 2500 in 1910 or 1920, and for the remaining settled area of every county, unsettled areas (including minor civil divisions of less than 50 inhabitants) being left blank. It is thus possible from the map to compare the cities and larger towns with one another and with the less thickly settled parts of each county, but it is not possible to compare individual small towns.

Three different types of area are shown:

1. Cities, towns, and other incorporated places for which the 1920 census gives the number of native whites of native parentage (Fig. 4, Symbols 1–5).

2. Towns for which the 1910 census, but not that of 1920, gives the number of native whites of native parentage (Fig. 4, Symbol 6).

3. Settled areas in each county not included in areas of either Type 1 or 2. These areas, in turn, are of two types:

   3a. Those which lie in counties that *do not* include areas of Type 2.

   3b. Those which lie in counties that include areas of Type 2.

For all areas of Types 1 and 3a the percentages were calculated directly from the 1920 census figures. For all areas of Types 2 and 3b they were estimated on the basis of a comparison of the 1910 and 1920 census reports.

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[6] See C. E. Batschelet: A Picture of the Distribution of Population in Pennsylvania, *Geogr. Rev.*, Vol. 17, 1927, pp. 429–433.

AN ISOPLETH MAP OF LAND UNDER CROPS IN INDIA

Wellington D. Jones
University of Chicago

THE government services in India have long gathered and published valuable data on the details of land utilization in this great low-latitude country, data comparable in accuracy and scope with those gathered in the more advanced countries of the Western World. The recently published "Report of the Royal Commission on Agriculture in India"[1] admirably summarizes this work as well as the wide variety of fundamental researches carried on by the agricultural services. In addition, this Report includes numerous recommendations for further work, including soil surveys. As a geographer reads these recommendations, however, he wonders at the lack of recognition of the need of publication of a variety of maps at present unavailable, maps which portray the areal spread of the agricultural facts now set forth only in statistical tables. One such fundamental map much needed is that showing the distribution of land under crops. To supply this need in a preliminary way the accompanying map of percentage of land in crops has been constructed, based primarily on statistical data published for some three hundred odd small political divisions covering about three-quarters of the area of the country, excluding Baluchistan.

In order to construct the map here presented, the appropriate ratio was calculated for each statistical division and plotted in the center of the division. Descriptions in the "Imperial Gazetteer of India" of relief, soil, and land utilization, together with information on detailed topographic maps published by the Survey of India, were then used in numerous places as a basis for inferences as to proportion of area under crops, which inferences enabled isopleths to be drawn with greater probable accuracy than would have been possible had the statistics alone been employed. The map undoubtedly is far from precise in many places, but it comes much nearer representing reality than a map constructed solely from the plotted figures. The probable degree of accuracy of the map is lower in the eastern part of Central India Agency, in Orissa, and in the eastern part of the Central Provinces, than elsewhere, since agricultural statistics are not available for many native states in these areas.

[1] Cmd. 3132, June, 1928. The total cost of the Commission is estimated at about £102,955. See the discussion of the Report in *Nature*, Vol. 122, 1928, pp. 134–135 and 175–177; Vol. 123, 1929, pp. 233–235.

This map, approximate though it be, puts the published data in a form suitable for geographic use. It shows, as statistical tables cannot, the extent and location of areas where a large part of the land is under crops (80 per cent is about the maximum) and the areas where but a small part is under crops. It brings sharply to the investigator's attention the question as to why the percentage of crop

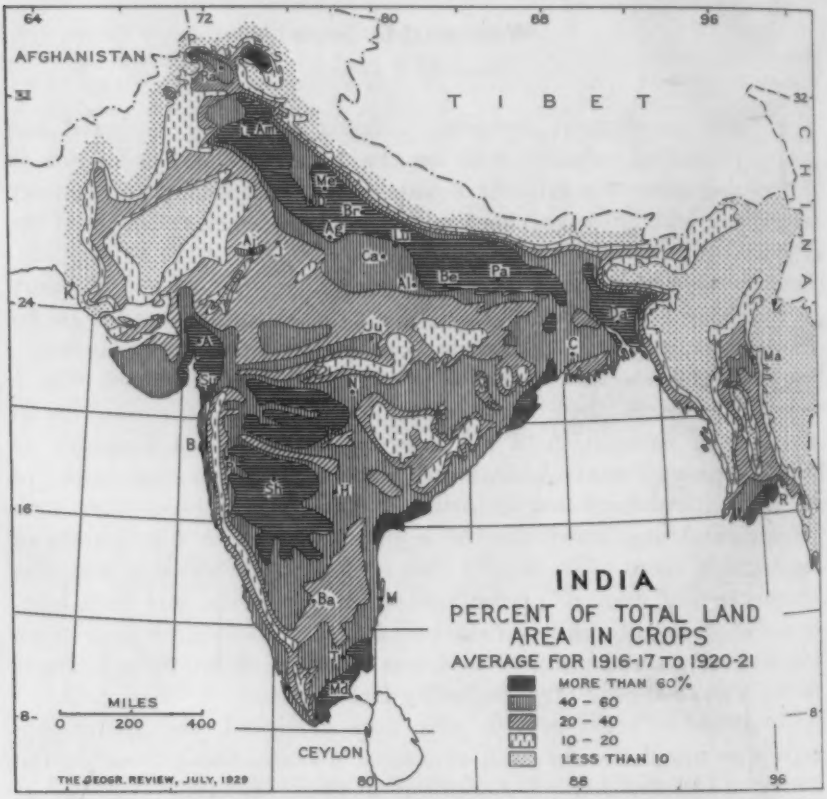

FIG. 1—Isopleth map showing the percentage of total land area that is under crops in India. Cities of more than 100,000 population are indicated by dots and initial letters. Scale 1:32,000,000.

land is high in certain regions and low in others, as well as the question as to what are the possibilities, in various sections of the country, of increasing the cropped area.

Such a map could be made by the agricultural services in India, based not only on the statistical data and the literature but also on the wealth of detailed field knowledge available, which would possess a high degree of accuracy. As a basis for present studies, and as a record some years hence, such a contribution to the knowledge of this land, where nearly three-quarters of the three hundred and twenty millions of population are directly dependent on agriculture, is greatly to be desired.

AMERICAN GEOGRAPHICAL SOCIETY

Meetings of March and April. At the regular monthly meeting of the American Geographical Society held on March 26, 1929, at the Engineering Societies' Building, 29 West 39th Street, President Finley presiding, Mr. Lowell Thomas gave a lecture entitled "Through Romantic India and into Forbidden Afghanistan." In 1923, after repeated attempts to gain admittance, Mr. Thomas entered Afghanistan by way of the Khyber Pass. The description of his experiences in the country was illustrated by striking motion pictures.

At the regular monthly meeting of the Society on April 23, 1929, held at the Engineering Societies' Building, 29 West 39th Street, Honorary President Greenough in the chair, Captain Sir Hubert Wilkins addressed the Society. He spoke on "Antarctic Exploration by Airplane," prefacing the account of his Antarctic experiences by a summary of the Arctic work of 1926, 1927, and 1928. The address was illustrated by motion pictures taken during the preliminary flight about Deception Island and on the great flight to latitude 71° 20′ S. Pictures were also shown of the whaling activities at Deception Island. The complete report of Captain Wilkins' season's work in the Antarctic is printed on pages 353–376 of this *Review*.

Elections to Fellowship. At the March meeting of the Society, President Finley presiding, and the April meeting, Honorary President Greenough presiding, there were presented with the approval of the Council the names of 42 candidates who were duly elected as Fellows of the Society.

The Map of Antarctica. The Society's large four-sheet map of the Antarctic prepared as the field map of Commander Byrd's and Captain Wilkins' expeditions (see *Geogr. Rev.*, Vol. 19, 1929, p. 148) is being revised and reissued as fast as new information becomes available. The American Quadrant, which includes Graham Land, has been redrawn to include Captain Wilkins' discoveries (see Pl. IV, facing p. 374) and will be issued without cost to all holders of the original map who will send their names and addresses to the Society. The quadrant will correspond in lettering, color, and size to the original one. A similar reissue of the Pacific Quadrant of the map of the Antarctic will be made after Commander Byrd's longer flights of the coming season.

Log Books of the U. S. Brig "Rescue." Through the kindness and generosity of Miss Cora Griffin and Mrs. Herbert R. Woods, daughters of the late Samuel Palmer Griffin, there have been given to the Society the two log books of the U. S. Brig *Rescue*, which cover the period (1850–1851) in which the ship was in the service of an expedition commanded by Captain Griffin which set out to find Sir John Franklin. The log books are of special interest as part of the source material relating to the history of that long search in which so many historic ships and explorers participated.

Captain Sir Hubert Wilkins' Original Records. After his return from the Alaska-Spitsbergen flight of 1928 Captain Sir Hubert Wilkins gave to the Society all of his original records, including his navigational charts, log books, and notebooks. Upon his return from the Antarctic in March, 1929, Captain Wilkins again gave to the Society all of his original maps and notebooks as well as a collection of his most important photographs. The value to science of such original materials is almost incalculable, and interest in them becomes especially keen when we recall that the period is fast closing in which there remains any important extent of still undiscovered coast.

GEOGRAPHICAL RECORD

NORTH AMERICA

The Mammoth Cave Region. In a booklet, liberally illustrated with sketches, block diagrams, and photographs, Dr. A. K. Lobeck gives a popular description of "The Geology and Physiography of the Mammoth Cave National Park" (*Kentucky Geol. Survey*, Ser. 6, Pamphlet 21, Frankfort, 1928). He utilizes the method adopted by him in the "Guide to the Allegany State Park" (see the *Geogr. Rev.*, Vol. 18, 1928, p. 702) and links up the local physiography with the general physiographic principles involved in the study of karst topography. A more detailed and technical account of the geology and geologic resources of the area is contained in "The Geology of Edmonson County," by J. M. Weller (*Kentucky Geol. Survey*, Ser. 6, Vol. 28, Frankfort, 1927). The comparatively recent publication of a number of U. S. Geological Survey topographic maps of the area has encouraged the study of the local sink hole topography. It has been estimated that the Mammoth Cave quadrangle alone shows 2833 sink holes and that the surrounding area contains no less than 60,000 to 70,000 (W. R. Jillson: The Topography of Kentucky, *Kentucky Geol. Survey*, Ser. 6, Vol. 30, Frankfort, 1927). Through the region flows the Green River marking in a general way regions dissimilar both physiographically and culturally. To the south "lie all the caves of the region and here, too, sink holes and valley sinks abound. Flat-topped plateau remnants make up a large fraction of the area although over one-half of the original plateau has given way to sinks and depressions. It is under these flat-topped mesa-like pieces of country that the largest caves are found. The northern half is a rugged hilly country with few or no sinks except along a belt near Green River. . . . Culturally, there is also a noticeable difference in the two areas. This is due largely to the fact that the northern part is distinctly isolated owing to the presence of the Green River Gorge. . . . Poor roads and a distinct dependence upon resources characterize the northern areas." Quite the opposite are conditions to the south in the Pennyroyal plateau, with its many roads and railroads, its frequent towns and villages, its extensive farms and broad cultivated tracts. For a detailed description see "Geography of the Pennyroyal," by C. O. Sauer (*Kentucky Geol. Survey*, Ser. 6, Vol. 25, Frankfort, 1927).

The Mountains of Arizona and Sonora. Leo Waibel has made an interesting comparison (Die Inselberglandschaft von Arizona und Sonora, *Zeitschr. Gesell. für Erdkunde zu Berlin*, Sonderband zur Hundertjahrfeier der Gesell., herausg. von Albrecht Haushofer, 1928, pp. 68–91) between the residual mountains that rise from the extensive rock plains of arid Africa and the somewhat similar features of Arizona and Sonora, with both of which regions he has had field acquaintance. He emphasizes the large area of the worn-down rock plains and the small size of the residual mountains in Africa in contrast to the opposite relations in arid America, where the rock plains, or "pediments," are as a rule of restricted development between larger areas of moderately dissected mountains on one side and of heavily aggraded depressions on the other; and he ascribes the different areas of the rock plains in the two regions to the long quiescence of the one and the relatively recent deformation, largely by block faulting, of the other. He describes in some detail the peculiar drainage features of our arid Southwest and gives well deserved praise to Kirk Bryan's work on the "Papago country" of Arizona where the "Inselberglandschaft" has its best development in the United States. But, curiously enough,

Waibel rejects the idea that these island mountains are to be explained by a climatic modification of the normal cycle of erosion, perhaps because he does not recognize that the English word, erosion, includes two processes, river corrasion and areal degradation, to which Germans usually give the separate names of *Erosion* and *Abtragung*. Nevertheless he quotes with apparent acceptance Bryan's examples of the progressive stages of arid erosion (arid degradation being implicitly included therewith); and his own descriptions show clearly enough that the above-noted physiographic contrasts between arid America and arid Africa are due to nothing more than the earlier and the later stages of the cycle of arid erosion through which they have progressed. Furthermore, Waibel's essay makes it clear that the modifications by which normal erosion, such as characterizes moist climates, is transformed into arid erosion are chiefly associated with the great activity of the rills and rivulets of arid regions at times of wet weather, when in consequence of scanty plant cover they gain a transporting power vastly greater than rills and rivulets possess in plant-covered regions.

W. M. DAVIS

Earthquake History of the United States Exclusive of the Pacific Region. In 1925 the Coast and Geodetic Survey was authorized to carry on seismological investigations in the United States (see *U. S. Coast and Geodetic Survey Special Publ. No. 132*, 1927). In that year occurred an earthquake in the lower St. Lawrence Valley notable for its intensity and the extent of territory over which it was felt. Little damage was done, for the epicenter, on a fault line crossing the St. Lawrence 90 miles below Quebec, fell in an area of scant population, but it was sufficient to indicate the reality of the hazard and to attract general attention to the earthquake problem in the United States and Canada (E. A. Hodgson: The St. Lawrence Earthquake, February 28, 1925, *Trans. Royal Soc. of Canada*, Ser. 3, Vol. 21, Part II, Section IV, 1927, pp. 145–152).

Commander N. H. Heck divides the United States into five seismic regions: the northeastern, including New England and New York, which region shares in the principal earthquake activity of Canada and has much of its own; the eastern, including the Appalachian activity; the middle western, the area between the preceding regions and the Rocky Mountains; the western mountain region; and the Pacific coast region. The history of the last-named region is covered by two catalogues of earthquakes, from 1769 to 1897 and from 1897 to 1906 respectively, published as *Smithsonian Miscellaneous Collections*, and a third is now in preparation. In "Earthquake History of the United States Exclusive of the Pacific Region" (*U. S. Coast and Geodetic Survey Special Publ. No. 149*, 1928) Commander Heck presents a record of the seismic activity of the first four regions. Earthquakes of intensity 5 and over on the Rossi-Forrel scale are listed chronologically by regions; brief comment is made on the minor quakes, more considerable description of the major occurrences including those of 1663 and 1925 in the St. Lawrence Valley, that of Charleston in 1886, and the exceptionally interesting New Madrid earthquakes of 1811 and 1812.

Tropical Cyclones off the West Coast of Mexico. The increased volume of traffic since the opening of the Panama Canal has focused the attention of seamen and meteorologists upon the ocean bordering the west coast of Mexico, a region of dangerous summer and autumn cyclones. Though Mexican fishermen of the west coast have long been aware of the recurrence of the "lash of St. Francis," and though Sir William Dampier and later navigators have described these storms, their cyclonic character has not been recognized generally. In 1856 Redfield plotted the paths of thirteen cyclonic storms that occurred between 1842 and 1855, and the "Segelhandbuch für den Stillen Ozean" of the Deutsche Seewarte lists forty-five occurring between 1832 and 1892. Together they give an average of little more than one

storm per year. These two sources have been the basis for studies of tropical cyclones of the eastern North Pacific up to the present time.

Coöperation between seamen and the United States Weather Bureau has enabled Willis Edwin Hurd in "Tropical Cyclones of the Eastern North Pacific" (*Monthly Weather Rev.*, Vol. 57, 1929, pp. 43–49) to identify eighty-five tropical cyclones that originated off the west coast of Mexico between 1910 and 1928. September is the month of greatest cyclonic activity, and a maximum of thirteen storms occurred in 1925. In the "Atlas Climatológico de la República Mexicana: Período de 1921 a 1925" Pablo Vázquez Schiaffino has traced the trajectories of thirty-eight cyclones occurring between 1921 and 1925. Of these, twenty-eight were also identified by Hurd, but ten were not otherwise recorded. This increases to ninety-five the number of storms noted between 1910 and 1928—making an average of five annually.

Four types of cyclones are recognizable: (1) those paralleling the coast of Mexico from Tehuantepec northward; (2) those of more southerly origin moving northward and striking upon the Mexican coast; (3) the storms originating near the Revillagigedo Islands and moving to the northwest or southwest; and (4) the less frequent storms originating between longitudes 125° and 155° W. Since 1832 but seven storms belonging to this last group have been definitely identified. Beyond longitude 155° W., to the southwest of Hawaii, is a region covered by few observations. Though evidence indicates that some northward-moving storms originate here, the fact is not established. Further observations will be needed to bridge the hiatus between the area of Mexican cyclones and that of the Oriental typhoons.

In the "Atlas Climatológico de la República Mexicana" Schiaffino has extended the paths of several Pacific cyclones across the plateau of Mexico to the Gulf. An extreme case is plotted on the "Carta del Tiempo" of the Servicio Meteorológico Mexicano for September 23, 1928. A cyclone originating in the Caribbean Sea is traced across the plateau of Mexico to the Pacific Ocean near Acapulco. Here it recurves, crosses the northern plateau, and emerges upon the Gulf coast near Matamoros. The period between September 16, when the storm first entered the mainland of Mexico, and September 23, when it disappeared in the Gulf, was accompanied by storms of unusual severity throughout Mexico and especially between Tampico and Monterrey, where desert was converted into swamp and railroad tracks were washed away. Though occasional cyclones known to have originated in the Pacific have crossed the Isthmus of Tehuantepec and entered into the circulation of the Gulf of Mexico, Hurd questions the ability of such storms to rise above the escarpment of the western sierras. He attributes the occurrence of storms on both coasts to the simultaneous development of barometric depressions of independent origin.

A Russian Colony in Mexico. During twenty-five years of forced exile in Kars and another quarter of a century of voluntary exile in Lower California, a colony of peasants from the plains of southern Russia has maintained its identity. What will be its ultimate destiny? This question is raised by Oscar Schmieder in his study of "The Russian Colony of the Guadalupe Valley" (*Univ. of California Publs. in Geogr.*, Vol. 2, 1928, No. 14, pp. 409–434). Originally the Molokanye, "sectarians closely resembling the Scotch Presbyterians," formed a progressive element within Russia, which was unable to accept the dogma of the Orthodox Greek Church. Cultural isolation in the Armenian highlands fostered conservatism among them, and in the Guadalupe Valley the Russian *mir* system has been transplanted to Mexican soil. Land is owned in common, and shares of both good and poor land are distributed among the families in proportion to the size of each. Frequently a man's fields are not contiguous. This discourages the establishment of isolated farms and promotes community life.

Following the example of other Russian dissenters, the Doukhobors, for instance, many emigrated from Russia first to Canada. But the Molokanye found the climate

was too suggestive of their exile in Kars. In southern California, where a colony of Russian Mennonites had settled, the climate was satisfactory but the land too expensive. The Guadalupe Valley, fifty miles south of the Mexican border, offered abundant cheap land, a warm Mediterranean climate, fertile alluvial soil, and an adequate supply of ground water. Wheat, the chief crop, is raised in the winter without irrigation. During the dry summer season the fields are converted into pasture. When the Molokanye arrived, the best wheat land in the region produced sixty bushels per acre. Reckless cultivation has reduced it to fifteen. This decreasing yield is balanced by an increase in acreage under cultivation. American agricultural implements have added to the amount of land that one man can cultivate, and an almost unlimited quantity of land can be rented from the Indians. Frequently fields are so far removed from the village that, during periods of cultivation or harvest, it is necessary for the men to camp for weeks at a time near their work.

When the Russians came to the Guadalupe Valley they completely displaced their predecessors, ranch owners and Indians. Their few neighbors are chiefly Indians. A hundred miles to the south, the uninhabited San Borja Desert begins. The country between has a rainfall too scant (5–10 inches) and too irregularly distributed to permit farming except in places where the ground water supply is particularly favorable. Efforts to establish missions have resulted in the extinction of the Indians and the abandoning of the missions (Carl Sauer and Peveril Meigs: Site and Culture at San Fernando de Velicatá, *Univ. of California Publs. in Geogr.*, Vol. 2, 1927, No. 9, pp. 271–302). Distance from the capital has increased isolation, and until recently the Russians have been relatively free from government intervention. On the other hand, the small size of the community (about a hundred families) makes it difficult to maintain its independence. The United States to the north attracts the youth of the colony, and the Mexican government now demands that children under twelve attend a Spanish school. Older colonists, of Russian birth, are barred from entrance into the United States. The school children are too young to assert their independence. Today Colonia Rusa is largely composed of these two extremes of age.

SOUTH AMERICA

Settlement of the Tacna-Arica Boundary Dispute. The governments of Chile and Peru have agreed to settle the Tacna-Arica dispute by dividing the disputed territory. The actual treaty has not yet been concluded, but both governments have accepted as the final basis for the solution of the problem the stipulations proposed by the President of the United States in his note of May 14 addressed to the two governments.

The accompanying map has been prepared to show as accurately as available information will permit the region of the new boundary. The Tacna-Arica section of the La Paz sheet of the Society's Millionth Map of Hispanic America has been used as the basis of the compilation. This section of the sheet contains all the surveys and supplementary information available in 1922 when the sheet was published. It was reproduced by the U. S. Geological Survey on the scale of the original drawings (1:500,000) and used by the Special Boundary Commission, Tacna-Arica Arbitration, as the base map for their studies of the disputed northern boundary of the province of Tacna. To this compilation has now been added the survey of the region of this disputed boundary made by the Peruvian section of the above commission in 1925–1926—a detailed topographic survey based on triangulation tied to astronomically located points of which the longitude was determined by wireless time signals.

According to the stipulations suggested in the President's note, the Tacna department of the province of Tacna is to belong to Peru, the Arica department to Chile. The dividing line, however, is not to follow the old boundary between these districts.

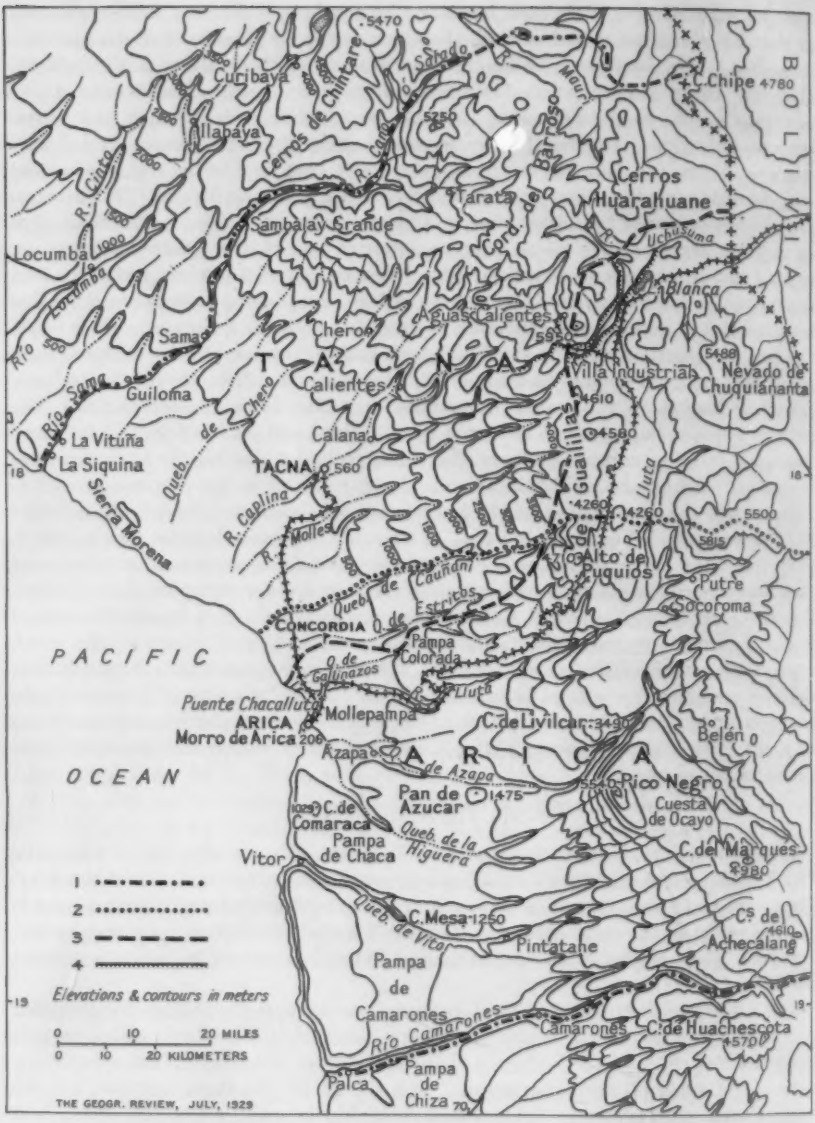

FIG. 1—Map showing the area concerned in the Tacna-Arica settlement. Numbers have reference: 1, boundaries of disputed provinces as defined by Chile; 2, old boundary lines between Tacna and Arica; 3, ten-kilometer line; 4, canals of Uchusuma and Mauri. Scale approximately 1 : 1,500,000.

It will "start at a point to be designated with the name 'Concordia,' situated ten kilometers north of the bridge over the River Lluta, and shall continue parallel to the Arica-La Paz Railroad, following, as far as possible, the topographic features which may make easier the demarcation of the line." The sulphur deposits of Tacora (presumably at Aguas Calientes, reached by a branch railroad from Villa Industrial on the Arica-La Paz Railroad) are to remain in Chilean territory; while "the canals of Uchusuma and Mauri, also known as Azucarero" (indicated on the

Peruvian survey of the Tacna boundary zone mentioned above as the Uchusuma and Azucarero canals) remain the property of Peru. This ownership by Peru is to be extended even to such sections of the canals as pass through Chilean territory and "includes the right to widen the actual canals, change their course, and appropriate all waters that may be collectible in their passage through Chilean territory." The boundary is to pass through the "center of Laguna Blanca, dividing it into two equal parts." The boundary is to be demarcated and monumented by a joint commission consisting of one Peruvian and one Chilean engineer and their assistants. Disagreements are to be decided by a third person designated by the President of the United States whose decision shall be final.

The government of Chile is to maintain in the Department of Arica the franchise granted by the government of Peru in 1852 to the Arica-Tacna Railroad Company, and is to grant to and construct for Peru within 1575 meters of the Bay of Arica a wharf, customhouse, and station for the Arica-Tacna Railroad "where Peru shall enjoy independence within the most ample free port."

Demarcation of the line will present certain difficulties. The bridge across the River Lluta referred to in the locating of "Concordia," the starting point of the boundary, is presumably the Puente Chacalluta, although this is not clearly indicated in the President's stipulations; and the line will proceed from this point to the Pacific and to the Bolivian border parallel to the Arica-La Paz Railroad and distant 10 kilometers from it except for minor adjustment to suitable topographic features and such major adjustments as the stipulations demand in certain sections. It will be seen from the map that, once this line reaches the Sierra de Guaililas, only minor adjustments will be necessary to keep the boundary to the main crest of the Sierra for a considerable distance. West of the Sierra de Guaililas, however, to keep the line parallel to the railroad will necessitate a highly arbitrary line which will cross and recross the upper tributaries of the Quebrada de Estritos and the lower portion of the Quebrada de Gallinazos. It is probable that the line finally established will lie between these two *quebradas*. The construction of the boundary so as to include the sulphur deposits of Tacora in Chilean territory will also involve considerable study and negotiation, as will its adjustment so as to fulfill the stipulation that it is to cross Laguna Blanca dividing it into two equal parts, since the *laguna* lies close to the railroad far south of the 10-kilometer line. Eastward from Laguna Blanca to the Bolivian border the course of the line is not mentioned in the stipulations. It would seem also that the rights of Peru in the ownership and maintenance of the Uchusuma and Mauri canals where they pass through Chilean territory, especially as regards the widening of them and the changing of their courses, must be definitely defined and limited if future difficulties are to be avoided. Westward from the Sierra de Guaililas to the Pacific Ocean too little information is available on present property holdings to permit any comment on the adjustment of the boundary to property lines.

The settlement of the Tacna-Arica boundary dispute leaves only two boundary problems of major importance in South America—the Bolivia-Paraguay dispute in the Chaco and the Peru-Ecuador dispute east of the Andes. These two disputes, however, involve, respectively, about 127,000 and 126,000 square miles. Excellent progress has been made since the beginning of the century in the settlement of boundary disputes throughout Hispanic America. Dr. Manfred Langhans-Ratzeburg, in "Die strittigen Gebiete der Erde seit 1900" (*Petermanns Mitt.*, Vol. 75, 1929, pp. 136–140), offers brief notes, accompanied by footnote references to various publications on the different disputes, on the status of all the boundary disputes in Hispanic America and the West Indies in 1900. He lists thirty-four disputes in 1900. Many of these were of little consequence, but a large number were of major importance. Of all these only thirteen now remain unsettled.

EUROPE

Southeastern France: Rhone Valley and Alps. Southeastern France is the unique possessor of two institutions devoted exclusively to regional geographical study—the well known Institut de Géographie Alpine at Grenoble, organized by Raoul Blanchard and now in its twenty-third year, and the recently established Institut des Études Rhodaniennes at Lyons. "Coordonner les recherches d'ordre physique et économique concernant le Rhône et ses principaux affluents ainsi que la voie de passage et la zone d'activité que constitue le couloir rhodanien (vallée de la Saône et du Rhône). Organiser, sur cette important région française, et européenne, une enquête scientifique permanente, susciter des courants d'idées, créer entre les chercheurs et aussi entre les foyers d'activité et de pensée dispersés au long de cet axe rhodanien un organe de liaison efficace" is the announced object of the Institute at Lyons. Its results are published in an annual statistical bulletin and an annual volume of "études et travaux." Thanks to the able direction of André Cholley, called to the Sorbonne at the end of 1927, and his successor at Lyons, André Allix, *Les Études Rhodaniennes* has already taken its place as an important addition to periodical geographical literature. The first volume, 1925, appropriately dealing with the entire river, is the monograph "Le Régime du Rhône," by Maurice Pardé. No such comprehensive work on the Rhone had been available hitherto. Moreover, as the study of a river which "combines all the hydrological régimes of western Europe" it has a particular value for comparative purposes. The succeeding volumes of *Les Études Rhodaniennes* (for 1926, 1927, 1928, and Fasc. 1, 1929) follow the usual plan and contain several articles and contemporary chronicle and review. Special reference might be made to the paper "Quelques remarques sur la culture et le commerce des fruits dans la banlieue de Lyon," by M. Cholley himself (Vol. 3, 1927), noteworthy for its truly geographical quality.

One of the most distinguishing features of the Rhone region is its rich variety. This is well brought out in "Plaines et bassins du Rhône moyen entre Bas-Dauphiné et Provence," by Daniel Faucher of the University of Toulouse, a monograph in characteristic French style. It treats of that part of the Rhone where the valley narrows and transition is made between the Midi and the north and where also converge influences from the Alps and the Central Massif (see the analysis by L. Gallois in *Ann. de Géogr.*, Vol. 37, 1928, pp. 177–180). Even in this region one notes the "drought or fear of drought" which conditions agriculture in the Midi. Irrigation is one of the major problems in the much discussed plans for improvement of the Rhone (Auguste Pawlowski: Transformation de la Provence inféconde, *La Nature*, No. 2798, 1928, Dec. 1, pp. 492–497). It is hoped to reclaim the desert areas of Camargue and Crau. "The Camargue . . . is at present a sparsely populated region, where mankind is repelled by a spread of malaria-breeding salt marshes, where the impression produced on the wanderers is that of a solitude more impressive than of the ocean, and where droves of cattle, goats, and horses, wander as wild and as free as on the plains of Texas" (R. D. Oldham: The Portolan Maps of the Rhone Delta, *Geogr. Journ.*, Vol. 65, 1925, pp. 403–428. On the historical problem see also his paper, "Problems of the Rhone Delta," *Nature*, Vol. 116, 1925, pp. 16–19, 52–54, and 100–102). The primitive economic state of the Camargue and the stony plain of the Crau is seen in the predominance of transhumance in these areas, a good description of which may be found in "Le mouvement économique: L'agriculture," by Paul Masson, a recently published volume of "Les Bouches-du-Rhône" (Encyclopédie départmentale publiée par le Conseil Général avec le concours de la Ville de Marseille et de la Chambre de Commerce sous la direction de Paul Masson, Vol. 7, Marseilles and Paris, 1928), a mine of information on the Rhone delta country.

Studies of the Rhone Valley and the French Alps naturally overlap. Such is

advisedly the case in M. Cholley's "Les Préalpes de Savoie (Genevois, Bauges) et leur avant-pays" (Paris, 1925). This monograph of 755 close-set pages is a most thorough-going piece of work. It deals with the Genevois and Bauges massifs of the Prealps (on the use of this term see Emmanuel de Martonne: Les Alpes, 1926, p. 204) and their "avant-pays" extending to Lake Bourget and the Rhone and constituting a passageway between the Jura and the Alps. M. Cholley is concerned with demonstrating the individuality of the region as a unit and with elaborating the diversities and contrasts within the unit. "Like most regions situated on the border of high massifs it is a privileged country of great variety, exhibit ng infinitely more shades of expression than either the high mountains or the neighboring plains." This is the underlying thought of the discussions of morphology, climate, man, natural conditions, and types of life from ancient to modern times that form the major categories of the treatise, a convenient summary of which is given by M. de Martonne in *Annales de Géographie* (Vol. 35, 1926, pp. 363–367). The political and economic history of Savoy, thanks to its situation, presents no little of interest; and one point in particular may be noted here: M. Cholley's treatment of that problem in political geography presented by the zonal régime to which the northern part of Savoy was subjected. The volume suffers one serious drawback. While it contains a number of small sketch maps and diagrams—there are no less than six on distribution of the forest lands—there is no good general map: one on a scale commensurate with the high detail of the text is sorely needed. An index also is greatly to be desired.

Of the *Revue de Géographie Alpine* we need only say here that it continues its fruitful production of local studies of the French Alps. Among its papers of wider scope that have recently appeared are a series of industrial studies by Professor Blanchard, the latest of which are "L'industrie des chaux et ciments dans le Sud-Est de la France" (Vol. 16, 1928, pp. 255–376) and "La grande industrie chimique dans la France du Sud-Est" (*ibid.*, pp. 561–624) and a paper by Jeanne Bouchet, "La culture du blé dans les Alpes françaises, 1913–1924" (*ibid.*, pp. 625–667).

In all these studies the great importance of the climatic factor is in evidence; and we cannot conclude this note better than by reference to the admirable work, "Le climat des Alpes françaises," by Ernest Bénévent (*Memorial de l'Office National Météorologique de France No. 14*, Paris, 1926), who takes up the climatic elements in the order: winds, temperature, precipitation, and brings them together in his conclusion "Limite climatic," in which he dwells on the importance of the climatic boundary separating the French Alps into northern and southern divisions. The rarity of studies on this order for mountain regions enlarges its merit. One looks eagerly to such data as are given, for instance, on the snowfall, the snow cover and its influence on the life in the mountains, and the intensity of precipitation in the high mountains. Bénévent believes the greatest precipitation is to be attributed to the Diosaz Valley on the southwestern flank of the Aiguilles Rouges where at the zone of maximum precipitation the rainfall is estimated at 5000 millimeters (200 inches). He lays stress on the secondary rôle played by mere altitude and on the absolute importance of situation.

The Economic Regions of France. On October 29, 1927, the Twentieth Economic Region of France, comprising Upper Alsace and the old province of Franche-Comté, was formally inaugurated (see Pierre Mandoul: La région économique Franche-Comté-Haute-Alsace, *Rev. Écon. Internatle.*, Vol. 4, 1928, pp. 265–287). "Regionalist" sentiment in France has been growing since the pre-war period (see *Geogr. Rev.*, Vol. 7, 1919, pp. 115–116; Vol. 14, 1924, p. 144). It represents a reaction against the tendency toward excessive centralization that has been characteristic of French political and economic life for centuries. The conception had arisen, as Henri Hauser has put it, of France "as a sort of economic nebulosity, swept along in the orbit of

Paris." By the outbreak of the war, however, this conception was being abandoned, partly as a result of the rapid increase in population and influence of the provincial cities and also in no small measure owing to the work of geographers, especially of Vidal de la Blache and his disciples of the regional school.

The war contributed directly toward the definite organization of economic regions (see Henri Hauser: Le problème du régionalisme, histoire économique et sociale de la guerre mondiale, Publications de la Dotation Carnegie pour la Paix Internationale, Paris and New Haven, 1924). A long period of discussion, mutual adjustment of conflicting interests, and experimentation, however, had to be gone through before "the organization could be considered even approximately complete." This status was reached by the summer of 1921. The regional organizations represented by their councils perform varied tasks. They themselves undertake and encourage the universities and other institutions in carrying out studies relating to manufacturing, commerce, public works, power resources, the tourist industry, and other matters affecting the economic status of their respective regions. They enter into negotiations with the regional councils of neighboring regions over points of common concern. They establish laboratories, museums, and institutions of research, and they publish periodicals. One region has undertaken the compilation of a statistical and economic atlas.

At first, Franche-Comté was assigned to the Twelfth Economic Region, which comprises Burgundy and has its center at Dijon. This arrangement was not satisfactory to the Chamber of Commerce of Besançon which, as a consequence, persisted for several years in standing aloof. Finally the matter was adjusted by the creation of the new Twentieth Region. The organization of this region is of particular interest, since the districts which are today included in it "during a period of nearly twenty-two centuries have been almost continually united by historic ties . . . particularly ties of an economic order . . . ." Even "the war of 1870 and the treaty which brought it to an end did not succeed in destroying the solidarity of these two districts (Upper Alsace and Franche-Comté). The new frontier was, without doubt, a difficult barrier to cross, and the environs of Belfort assumed a strategic importance little favorable to the growth of commerce. In spite of this the industries of Mulhouse established branches in Belfort and on the western slopes of the Vosges." The maintenance of the age-old economic connection between Upper Alsace and Franche-Comté and the reaffirmation of the connection in the inauguration of Twentieth Region certainly owes something to a geographic factor: the Pass of Belfort, that famous gateway of eastern France that offers a ready avenue between Vosges and Jura from the valley of the Rhine into that of the Saône.

A Recent Study of Urban Geography in Sweden. The results of an important study of certain towns in the Mälardalen area of Sweden made in 1925–1926 by Dr. John B. Leighly have recently been published by the University of California ("The Towns of the Mälardalen in Sweden: A Study in Urban Morphology," *Univ. of California Publs. in Geogr.*, Vol. 3, No. 1, Berkeley, Cal., 1928). The area investigated formed the nucleus of the Swedish nation. It lies about the great island-dotted Lake Mälar, at whose outlet to the Baltic stands the city of Stockholm. The particular towns studied range in population from about 800 to just over 30,000 inhabitants, the best known of the group being Upsala, with a population of 30,255.

Dr. Leighly regards towns "as landscape features of cultural origin, whose forms have their present character because of the continuous action of cultural forces, as the natural features of the landscape are the products of natural forces acting through time," "landscape" here being used in the special sense in which the author's colleague, Professor C. O. Sauer, employs the term. Besides illustrating a point of view regarding objectives in geographical research that is finding favor among not a few American geographers, Dr. Leighly's monograph contributes observations of

fact that are of broad interest. The manner in which the particular towns studied have acquired the physical forms they now present is doubtless typical of many other centers in northern Europe.

Unlike the Mediterranean folk, the early Germanic peoples were not builders of cities, and the way in which cities have grown in northern countries during medieval and modern times has been influenced to no small degree by ideas that have come in from the south. The existing form of the Swedish town is thus the resultant of an interplay of two cultural forces, the indigenous and the exotic. When, during the Middle Ages, the beginnings of commerce and of ecclesiastical organization gave rise to the concentration of population in urban groups, the towns carried over many of the structural characteristics of the agricultural village. In the village the farm unit consisted of a dwelling house with a number of subsidiary structures, each serving a different function and standing well apart from its neighbors. A similar subdivision of functions was preserved in the towns, and, indeed, not until the nineteenth century did there come a "change toward a 'modern' type of occupation of the land, with the functions of the establishment concentrated in a single large house facing the street."

Since Sweden is largely forested, most of the houses there are made of wood. This creates a fire hazard—somewhat diminished in the agricultural villages by the dispersal of the buildings. "Mediterranean urbanism, [on the other hand,] was based on a relatively fireproof building culture, which permitted a close arrangement of buildings. The idea of close crowding of numerous dwellings was adopted by the Northerner in the founding of the settlements to be made under the influence of the urban culture, but he retained his wooden houses." Conflagrations were the inevitable result. At one time or another most of the towns were razed in whole or in part by fire. This made possible more frequent changes, not only in architectural styles but in street plan, than would have been possible if the urban form had become "petrified" through fireproof construction.

Town planning seems to have been unthought of in medieval Europe. The pattern of houses and streets grew irregularly, in conformity with the topography and with considerations of convenience. The Renaissance brought a passion for classic regularity and rectangularity. After about 1600 a Swedish town, when it had burned, was reconstructed with rectangular streets, and new quarters were laid out on rectangular lines. Recently, in Sweden as elsewhere, there has been a reaction. Curving streets are now in favor. We thus find that in many towns "the nucleus, thanks to fire and to the engineers of the seventeenth, eighteenth, and nineteenth centuries, is rectangular; the outer zones display the winding streets and irregular blocks of the new medievalism, together with the outposts of the towns which have grown without plans."

AFRICA

Exploration for Stock Routes in the Kalahari Desert. The Kalahari, though ill-defined, is estimated to comprise some 400,000 square miles—an area about three-quarters the size of the Union of South Africa. It "intrudes itself by pressing its borders on each of the separate states of South Africa, and the conquering of even these borderlands has been a regrettably slow process . . . its center, located only a couple of hundred miles to the west of Palapye Road, has not even been examined" (A. L. du Toit: The Kalahari and Some of Its Problems, *South African Journ. of Sci.*, Vol. 24, 1927, pp. 88–101). In 1928, however, a concerted attack was made on this unknown interior, three expeditions organized by the administration of the Bechuanaland Protectorate participating. The objective was to discover a practicable route for the export of cattle from the Ghanzi district on the northwestern border of the desert to the Rhodesian railway and Katanga. Like similar expeditions in Australia, the survey of the Canning stock route in Western Australia

(1906–1907) for instance, these expeditions have been productive of interesting geographical results.

To understand the objective of the expeditions one must go back thirty years to the founding of Ghanzi, one of Cecil Rhodes's colonies. The story of the first settlers, the twenty-five English and Dutch families who traveled over the waterless Kalahari by way of Khama's capital, Palapye Road, has been told by "one of them" in "The Great Ngami Trek" in *The Round Table*, No. 65 (Dec., 1926, pp. 81–101). It is an epic admirably told and above all touching in its tribute to South Africa's great colonizer. "After the Great Ngami Trek" in *The Round Table*, No. 74 (March, 1929, pp. 325–341) gives an equally luminous picture of life in Ghanzi today with the population numbering well over a hundred. "An airman hovering over our little colony would have a varied view. To the north and north-east he would see the bush-covered rocky kopjes, green and grey, which separate the Lake Reserve from the Ghanzi district with its rolling open plains, its tracks of bush, its ridges and valleys and its pans girt with trees; the homesteads, too, scattered about from one to fifteen miles apart, connected by wagon trails, each with its cattle kraal and its bit of garden, and here and there a windmill. The plains would also meet our airman's eye, with their troops of eland, wildebeeste, gemsbok, hartebeeste and ostriches, and the cattle and the flocks of sheep and goats in the neighbourhood of the farmhouses, a truly peaceful pastoral landscape. Here and there he would descry patches clear of game, the result of some raid by Bushmen or wild dogs. Near the centre of the picture and away from the other buildings, the magistracy premises would stand out with our newly erected meteorological tower. A self-contained little territory it is, still in a half wild state. There is not even a village, let alone a town, or a railway."

Ghanzi is excellent ranching country, and cattle are the mainstay of the little colony today but under the handicap of extreme transportation difficulties. A favorite route to the east has been via Lake Ngami and Victoria Falls; but the tsetse fly has appeared, and the establishment of a new track has become necessary if the Katanga market is to be retained. During the rains in the early months of 1928 Lieutenant H. Beeching with camel and ox transport pioneered a new route from Ghanzi to Metsematluk and Molepolole, which is connected by motor road with the railway. At the same time a six-wheeled lorry was despatched on a more northerly route from Serowe to Maun via the Botletle River. Lieutenant Beeching's expedition found water in limestone pans. The almost continuous limestone formation suggested the possibility of establishing an all-weather motor road; and accordingly in June, 1928, an expedition under Captain B. E. H. Clifford left Mahalapye on the Rhodesian railway with two motor lorries on the 400-mile trek to Ghanzi, picking up Lieutenant Beeching's trail about half-way across. Little water was found, since this was the dry season; but Captain Clifford ascertained that by digging through the limestone a shale is encountered which if penetrated to a depth of 10 to 15 feet will give a perennial supply of water (see "Bechuanaland Protectorate, Rept. for 1927–28" *Ann. Colonial Repts. No. 1424*). Grazing and water prospects appear favorable along this new track, but a great drawback to motor transport lies in the great number of punctures which render this means of travel decidedly uneconomic. Solid tires, on the other hand, bore too deeply into the sand. Captain Clifford describes his journey and a supplementary one to prospect a new fly-free route to Victoria Falls in the *Geographical Journal*, April, 1929, pp. 342–358.

Aerial Survey in Northern Rhodesia. The Rhodesian Congo Border Concession holds the mineral exploration rights over 52,000 square miles in Northern Rhodesia, an area lying immediately south of the Katanga-Rhodesia boundary and extending from the Angola frontier on the west to beyond the Northern Rhodesia Railway on the east. In all probability this is a rich mineral region; and in order to obtain,

expeditiously, a basis for intensive prospecting, the Aircraft Operating Co. was engaged to photograph 20,000 square miles of the concession. With the exception of the Rhodesia-Congo boundary and several of the chief rivers, the country was unsurveyed and so undeveloped that it was necessary to clear forty-three emergency landing fields before the flights commenced. Since experience had shown that the presence of salts in shallow soil over copper outcrops prohibits tree growth, the location of *dambos*, open spaces in the forest, was considered especially important, as a means of enabling the Company's geologists to concentrate their efforts on the more favorable localities (see G. L. Walker: Surveying from the Air in Central Africa, *Engineering and Mining Journ.*, Vol. 127, 1929, Jan. 12, pp. 49–52).

Although this aerial survey was primarily for the location of mineral deposits, coöperation in the field between the Rhodesian Congo Border Concession and the Imperial Forestry Institute resulted in a much wider study of the resources of the region. These findings have been published as Number 9 of the Oxford Forestry Memoirs (R. Bourne: Aerial Survey in Relation to the Economic Development of New Countries, with Special Reference to an Investigation carried out in Northern Rhodesia, Oxford, 1928). Mr. Bourne employed the method of familiarizing himself with local conditions on the ground, including a motor survey of 142 miles of road, and of then applying his deductions to the photographic mosaic. In this particular instance where climate and topographic conditions were favorable and the soils were residual he was able to draw definite correlations between the underlying rock, the soil, and the vegetation types. Weighing the findings of this survey and of a previous one in Burma (see *Geogr. Rev.*, Vol. 16, 1926, p. 145; and *Burma Forest Bull. No. 13*, 1926), Mr. Bourne concludes that, if the specialized knowledge of agriculturists, foresters, pedologists, and geologists is brought to bear on the problem in the field, a working plan for the development of an area can be easily and satisfactorily arrived at.

In addition to the already unusually wide scope of this survey, the government of Northern Rhodesia, interested in the navigation possibilities and water resources of the upper Zambezi River, has ordered a special survey of that river from Livingstone to a point some 400 miles up the stream and including the Lungwebungo River as far as the Angola boundary and some 150 miles of the Kabompo River (*African World*, No. 1300, Vol. 100, 1927, Oct. 8, p. 440).

The Demarcation of the Boundary between Jubaland and Kenya. In accordance with agreements made in 1919 and 1920 Jubaland, lying to the west of Italian Somaliland, was formally transferred from British to Italian sovereignty on June 29, 1925 (see *Geogr. Rev.*, Vol. 14, 1924, p. 150). During 1926–1927 the boundary between Jubaland and Kenya was surveyed and demarcated by a joint British and Italian commission. The work of the commission is described by the Senior British Commissioner, Lieutenant Colonel L. N. King, in a paper read before the Royal Geographical Society last year and supplemented by notes on the geography of Jubaland by Captain E. H. M. Clifford, Assistant Commissioner (*Geogr. Journ.*, Vol. 72, 1928, pp. 420–442). The line runs for a distance of 681 kilometers generally southward from the Daua River to the Indian Ocean. Since the country traversed was difficult of access and but little known, the commission was obliged to carry out a work of genuine exploration. As Sir Charles Close, President of the Royal Geographical Society, remarked in the discussion of the papers, most international boundaries in Africa pass through out-of-the-way regions; the series of boundary commissions "which started after 1884" has been "one of the chief means by which we have been enabled to develop, understand, and arrive at the proper appreciation of the real geography of Africa." The Jubaland-Kenya line was marked not only by the usual pillars and cairns but by a lane about twelve feet broad cut through the brush. It was thought that "such a line would be unmistakable to the local tribes,

that the brush was of a very slow-growing variety, [and] that the lane once cut would undoubtedly be kept open by natives driving their stock between pasturages. . ." Since 1926 not only has a considerable extent of the lane been opened up to motor traffic but other automobile roads have been developed.

Captain Clifford comments on the "featureless flatness" of the landscape in Jubaland. The northern part of the country consists of a plateau bounded on the north and south by escarpments and reaching a maximum altitude of about 700 meters. The central and southern parts form an undulating plain, with low hills along the coast. "Thorn bush, on the average about 11 to 12 feet high," covers most of the area, although there are forests in the south. As Jubaland lies under the equator, there are two rainy seasons each year. The mean annual rainfall, however, is only about 7½ inches, and, as in nearly all dry countries, the rain is highly irregular, often coming in spasmodic downpours. Water is obtained from scattered wells or, after rain, by digging below the surface of torrent beds. Captain Clifford believes that there are no springs. The population consists for the most part of Somali nomads and semi-nomads who have come from the east, driving out the Galla negroes. "The Somali is essentially a camel-owner, and the northern half of Jubaland is good camel country. But from about 1° N. southwards a variety of 'tabanus' fly, called 'baal,' appears in swarms with the rains." Most camels bitten by these flies die. "Consequently one only sees an occasional camel in the southern half of the country, and the stock there is entirely cattle, fat-tailed sheep, and goats." Official Italian statistics give for the area of Jubaland about 90,000 square kilometers, 34,750 square miles, and for the population approximately 100,000. Kismayu, the port and principal town, had 3600 inhabitants in 1925. Only about 460 square miles are believed to be susceptible of cultivation without very elaborate irrigation. (The Italian Ministry of Colonies has recently published a large volume on Jubaland, "Oltre Giuba," prepared under the direction of the High Commissioner, Corrado Zoli, and summarized in *Le Vie d'Italia*, Vol. 34 (6), 1928, pp. 24–32).

ASIA

Man and Nature in Central Arabia. In a volume entitled "Arabia of the Wahhabis" (Constable & Co., London, 1928) H. St. J. B. Philby completes the narrative of his explorations and diplomatic mission to Ibn Sa'ud of 1917–1918. At the close of an earlier work, "The Heart of Arabia" (see *Geogr. Rev.*, Vol. 13, 1923, pp. 484–485), the story breaks off upon Philby's return to Riyadh, the Wahabi capital, after a journey into southern Nejd during which a large tract of previously unexplored country was visited. "Arabia of the Wahhabis" opens with a striking account of the author's sojourn in Riyadh during Ramdhan, the month of fasting, which in 1918 happened to fall during the torrid heats of midsummer. Early in August Ibn Sa'ud, with "the full approval and active support of the British Government," embarked upon a campaign against Ibn Rashid, the Shammar emir of Hail in northern Nejd, hereditary enemy of the house of Ibn Sa'ud and ally of the Turks (see Alois Musil: Northern Negd, *Amer. Geogr. Soc. Oriental Explorations and Studies No. 5*, New York, 1928, pp. 250–252). Part of the time in company with Ibn Sa'ud, Philby made his way northward through the little-known region of Washm and into Qasim, then Ibn Sa'ud's northernmost province. He tells us much of life in the twin oasis cities of Qasim, 'Anaiza and Buraida. On entering the former, he writes, "It seemed to me that I had stepped suddenly out of barbarism into a highly civilized and even cultured society, where the stranger within the gates, far from being an object of aversion and suspicion, was regarded as the common guest of the community . . ." Buraida is only sixteen miles away. "Yet neither remorse nor enlightenment born of travel will ever wean the citizen of Buraida, when at home, from the bigotry in which his city has grown great among the cities of Arabia."

On October 2, after a visit to northern Qasim, Philby received the unexpected news that the British Government had reversed its policy in regard to Ibn Sa'ud's campaign against Haïl. His mission thus terminated, Philby was obliged to bid farewell and march down to Kuwait; and three years were to elapse before Haïl was finally incorporated into Ibn Sa'ud's territories. On the way to Kuwait the explorer saw from a distance in the desert, "in surroundings utterly dismal and unattractive, 'Artawiya, a great town of 10,000 inhabitants that had sprung into existence since 1912. The first *Ikhwan* colony to be founded, it is an epitome of the Wahhabi revival, which, under the wise and skilful guidance of Ibn Sa'ud, has brought the boon of peace, security and, in a measure, unity to Arabia."

The main value of Philby's now completed work lies in the insight it gives us into Arab life. The explorer's maps and notes, however, have also made possible the development of a general hypothesis regarding the physiography of Central Arabia. This hypothesis, based fundamentally on the reports of Philby but supplemented by reference to the observations of Doughty, Huber, Raunkiaer, Mackie, and Cheesman, is presented by Raoul Blanchard in "Le relief de l'Arabie centrale" (*Rev. de Géogr. Alpine*, Vol. 14, 1926, pp. 765–786). Blanchard compares the physiographic history and resulting relief of Central Arabia with those of central and northern France. Western Nejd, a tract of ancient crystalline rocks and of eruptive rocks of recent age, he styles the central massif of Arabia on the analogy of the Massif Central of France. Here the general trend of both granitic ridges and more recent eruptive masses from southwest to northeast suggests that the massif may have been broken by faulting associated with the tectonic movements that gave birth to the Red Sea. The massif as a whole appears to be the core of a vast dome or bulge that is cut across on the west and southwest by the coast ranges of the Hejaz and Asir but farther to the northeast, east, and southeast constitutes the structural element that determines the major relief features of inner Arabia. Over the central massif, denudation has stripped away the Secondary and Tertiary formations, laying bare the ancient basal crystalline foundation. Farther out from the center of the bulge, however—to the northeast, east, and southeast—the Secondary and Tertiary strata are still intact. They dip gently away from the massif and, as in the Paris Basin, give rise to a well defined and characteristic sequence of concentric scarps, cuestas, and lowlands. The original drainage pattern of the dome is preserved in consequent valleys running northeast, east, and southeast, directly through the cuestas. The lowlands between and parallel with the cuestas are obviously subsequent valleys eroded out along belts of less resistant rock. Most of the oases lie in these lowlands, and the greater part of the population of Nejd dwells there rather than farther west among the barren and forbidding rocky hills of the central massif.

Upon a diagrammatic sketch drawn after Philby's maps Blanchard shows the westward-facing scarps of the cuestas. He places their northernmost extremity at about latitude 27°, to the east of Buraida in Qasim. Alois Musil's map of northern Arabia published by the American Geographical Society, however, shows what appears to be a well developed series of scarps, cuestas, and lowlands still farther north, between the Nefud desert and Mesopotamia.

A further attempt at geographical synthesis on the basis of the fragmentary evidence available regarding the surface of northern Arabia takes the form of a map by Dr. Adolf Käselau (see *Petermanns Mitt.*, Vol. 74, 1928, pp. 341–342, and Pl. 39) showing a classification of the land according to its relative value to the Bedouins. Four types of surface are differentiated: (1) *harras*, or volcanic tracts covered by eruptive rocks of recent origin; (2) other "regions of hardship" (Kümmergebiete); (3) neutral regions; and (4) favored regions. The last-named include the sandy deserts (Nefuds), upon which there is an abundant bushy vegetation, the oases, the valleys of the principal wadies, and a strip along the Persian Gulf.

POLAR REGIONS

Bouvet Island. In his article "Modern Norwegian Whaling in the Antarctic," printed in this number of the *Review* Major Isachsen briefly refers to the work of the *Norvegia*. On November 30, 1927, this vessel, fitted out by Consul Lars Christensen of Norway for a commercial and scientific voyage, sighted Bouvet Island in latitude 54° 26′ S. and longitude 3° 24′ E. The following day the captain landed and took possession in the name of Norway. Within the next few days the island was circumnavigated; soundings, sketches, and photographs were taken; and landings were effected in a few places. In appearance the island, which is of volcanic origin, is pentagonal in shape, being about 7½ by 9½ kilometers. Its snow-clad sides rise evenly to a central plateau, the highest points on which are above 900 meters. Practically no vegetation and only the lowest forms of animal life were found. The surrounding water and sea were teeming with life, and a number of fur seals were killed by the expedition (see Haakon Mosby: Bouvet-øen og "Norvegia" ekspedisjonen 1927–1928, *Naturen*, Vol. 52, 1928, pp. 321–333). The *Norvegia* remained in the vicinity until January 1, 1928, making observations.

In January, 1928, the British Colonial Office announced that the whaling concession "to the territorial waters of Bouvet and Thompson Island" had been let to a Norwegian firm. The Norwegian government pointed out that the island had been taken possession of in the name of Norway; and on November 19, 1928, it was announced that the British claim to Bouvet Island was waived in favor of Norway. Although, in 1739, in this general neighborhood Bouvet sighted land which was subsequently seen by several explorers and unsuccessfully sought after by others, the first landing was made by the English Captain Norris who in 1825 sighted two islands, one in latitude 54° 15′ S. and longitude 5° E. and one in 53° 56′ S. and 5° 30′ E., which he named Liverpool and Thompson Islands respectively. He landed upon Liverpool Island. The British claim to Bouvet Island was based on Captain Norris' discovery. Uncertainty prevailed as to the exact number and location of the islands until 1898 when a German deep-sea expedition on the *Valdivia* failed after much searching to find any of the islands in the positions assigned them by their discoverers but did locate land in latitude 54° 26′ 4″ S. and longitude 3° 24′ 2″ E., which was named Bouvet Island. It was this island that was taken possession of by the *Norvegia* in 1927. Since exact location was difficult to ascertain on account of prevailingly bad weather of the region, it had been supposed that the Bouvet Island of the *Valdivia* expedition was the same as either Liverpool or Thompson Island of Captain Norris. The assumption has been questioned by Consul Bjarne Aagaard in his pamphlet "The *Norvegia* Expedition and Bouvet Island" (Oslo, 1928). An analysis of the matter is made in the *Geographical Journal* for December, 1928 (pp. 537–546), with the conclusion that there seems to be no reasonable grounds for doubting the identity of Liverpool Island and Bouvet Island.

The existence of Thompson Island in the same neighborhood still seemed possible, and therefore the *Norvegia* in December, 1928, after visiting Bouvet Island and preparing for the establishment of a meteorological station there, searched for eight days but, finding no land, came to the conclusion that Norris had probably seen an overturned iceberg (see Bjarne Aagaard: Antarctic Whaling and Exploration, *Scottish Geogr. Mag.*, Vol. 45, 1929, No. 2, pp. 65–81).

OBITUARY

E. Lester Jones. Colonel E. Lester Jones, director of the U. S. Coast and Geodetic Survey, died in Washington on April 9, 1929, in the fifty-third year of his age. Colonel Jones's administration from his appointment in 1915 was a notable achievement, as is shown by the annual report of the Bureau for 1928 in which is sum-

marized the progress of the last ten years. During this time nearly half of the coasts of the United States from Canada to the Mexican border has been surveyed; in southeastern Alaska all the through steamer routes are now charted, and the original survey of the outside coast of this region has been completed; "1926 was the first year in our history in which not a single wreck occurred in Alaska waters." An adjustment of the triangulation nets of the western half of the United States has been accomplished, involving the results of 13,000 miles of arcs of triangulation; in coöperation with the Geodetic Survey of Canada triangulation has been extended from the United States through the coastal waters of British Columbia and Alaska; a readjustment has been made of the precise-level net, as a result of which it appears that the Pacific Ocean along the western coast of the United States is on an average about two feet higher than the waters of the Gulf and the Atlantic along the southern and eastern coasts. The first magnetic survey of the United States has been substantially completed. In addition to the prosecution of the regular services with improved technique and production, the Coast and Geodetic Survey has embarked on new tasks—the production of aerial navigation maps of the United States, investigations in seismology, current surveys of the principal harbors of the country, and maintenance of the variation-of-latitude station at Ukiah, Cal.

Constant effort to promote the work of the Bureau appears in Colonel Jones's writings, for instance, the U. S. Coast and Geodetic publications, "The Neglected Waters of the Pacific Coast: Washington, Oregon, and California" (*Special Publ. No. 48*, 1918), "Safeguard the Gateways of Alaska: Her Waterways" (*Special Publ. No. 50*, 1918), "Earthquake Investigation in the United States" (*Serial No. 304*, 1925), just as he earlier pleaded for the development of Alaskan resources while acting as Deputy Commissioner of Fisheries in his "Report of Alaska Investigations in 1914."

John William Harshberger. Dr. Harshberger, professor of botany in the University of Pennsylvania, died in Philadelphia on April 27, 1929, in the sixty-first year of his age. His special field was plant geography and ecology. He had traveled extensively; but his numerous writings (see the bibliography in "The Life and Work of John W. Harshberger, Ph.D.; An Autobiography," Philadelphia, 1928) related mainly to North America, his *opus magnum* being the "Phytogeographic Survey of North America" (1911) in "Die Vegetation der Erde" Series (see the review by R. M. Harper; *Bull. Amer. Geogr. Soc.*, Vol. 45, 1913, pp. 38–42). His publications also include "The Vegetation of South Florida" (*Trans. Wagner Free Inst. of Sci. of Phila.*, Vol. 7, Part III, 1914); "The Vegetation of Nantucket" (*Bull. Geogr. Soc. of Philadelphia*, Vol. 12, 1914); "The Vegetation of the New Jersey Pine-Barrens" (1916); "A Comparison of the Alpine Regions and Vegetations of Eastern America, Norway and Switzerland" (Festschrift Carl Schröter, 1925; pp. 271–278 as Heft 3, *Veroffentl. Geobotan. Inst. Rübel in Zürich*); "Tundra Vegetation of Central Alaska Directly Under the Arctic Circle" (*Proc. Amer. Philos. Soc.*, Vol. 67, 1928, pp. 215–234). To the *Geographical Review* he contributed "Alpine Fell-Fields of Eastern North America" (Vol. 7, 1919, pp. 233–255) and "The Gardens of the Faeroes, Iceland, and Greenland" (Vol. 14, 1924, pp. 404–415); and he is the author of "Unsolved Problems in Arctic Plant Geography" (Problems of Polar Research, *Amer. Geogr. Soc. Special Publ. No. 7*, 1928, pp. 143–153).

Dr. Harshberger was also actively interested in conservation. He was president of the Botanical Society of Pennsylvania and of the Philadelphia Natural History Society and had served as president of the Ecological Society of America (1926). He was a director of the Geographical Society of Philadelphia.

GEOGRAPHICAL REVIEWS

Monsoon Asia

Jules Sion. **Asie des moussons.** Part I: **Généralités—Chine—Japon.** 272 pp.; maps, diagrs., ills., bibliogrs.; Part II: **Inde—Indochine—Insulinde.** Pp. 273-548; maps, diagrs., ills., bibliogrs., index. (Géographie Universelle, Vol. 9.) Librairie Armand Colin, Paris, 1928. 70 frs. for each part. 11¼ x 8 inches.

Professor Sion's book is accurate, up-to-date, and delightfully written. It gives a comprehensive description of southern and southeastern Asia, the home, as the author reminds us, of over half the human race—a region where, throughout the ages, extreme political instability has gone hand-in-hand with an extraordinary stability of culture.

The first three chapters of Part I are general in nature and treat of the geology, climate, vegetation, and modes of life. The mechanism and effects of the monsoons are described; and the author points out one of their essential characteristics which is too often overlooked, viz. the great fluctuations in both summer and winter rainfall from year to year. He also shows that the true rôle of irrigation is not merely that of supplying water where it is lacking, but rather that of equalizing the irregularities of the monsoon rains. In general, the author's viewpoint is that of the futility of geographical determinism alone as an explanation of the types of culture characteristic of monsoon Asia.

The remaining chapters of Part I deal more particularly with China and Japan. The chapter on North China gives an excellent account of the remarkable loess region and the great coal fields of Shansi. It also emphasizes the important fact that the Hwang Ho, or Yellow River, is geologically extremely immature. The chapters that follow deal with the Yangtze basin, with South China, with the economic geography of China as a whole, and finally with the question of population. The importance of agriculture in China is noted, as is the fact that industry and manufacturing are still largely of the household type. Consideration is also given to the place of mining in the national economy. In the author's study of the population he speaks of the high mortality and points out that China in this respect is today where India was before the British occupation.

In regard to the origin of Chinese civilization, the author takes issue with a recent writer on the same subject, Henri Maspero ("Les origines de la civilisation chinoise," *Ann. de Géogr.*, Vol. 35, 1926, pp. 135–154; transl. in *Ann. Rept. Smithsonian Instn. for 1927*, pp. 433–452). Maspero, basing his conclusions largely on a critical study of the written sources, believes that Chinese civilization originated in the Great Plain, along the lower course of the Yellow River. Only much later, he thinks, did it extend westward, into the true loess country. Professor Sion, on the contrary, holds that the movement was from west to east; that, in other words, the archaic Chinese civilization occupied the loess region before it spread over the plain. His belief is amply corroborated by a study of the culture phenomena themselves. For the ancient civilization of China possessed so many of the same fundamental elements upon which were based the great historic cultures of the Near East, that any possibility of a wholly independent origin is precluded. And inasmuch as these features appear, generally speaking, much earlier in western Asia than in China, their diffusion must have been from west to east.

The author then outlines the history of China down to modern times and concludes with a fair summing up of the difficulties facing the new national government.

The last four chapters are devoted to Japan and its dependencies. Their relief and geology are described in some detail, as are the climate and its influence on vegetation. There follows an account of the formation of the Japanese state, with a brief sketch of its development from prehistoric times. The author's suggestion that the rice-culture complex in Japan must have been derived from Korea rather than from southern China, because the Japanese peasant uses the ox instead of the water buffalo, is scarcely convincing. The growing of rice seems to have spread over all these parts of the globe far earlier than did the use of plow animals. The two sets of culture phenomena are quite unrelated. The descriptions of Japanese life as a whole, however, are at once lucid, accurate, and sympathetic.

In the chapter on modern Japan it is pointed out that sixty per cent of the people are still agricultural but that the movement toward the cities, so characteristic of modern life, has already begun. The present-day economic problems of Japan and their solution are also discussed. In the last chapter the colonial empire of Japan, more especially in its economic aspects, is the object of study. An interesting comparison is drawn between the official character of Japanese colonization and that of ancient Greece and Rome, where also governmental action instead of popular initiative was the moving force.

Hokkaido (Yezo), Sakhalin, and the Kuriles are described; and both Korea and Manchuria receive extended notice. The Loochoos, Formosa, and Micronesia are also dealt with in turn. Korea, we are told, is destined to serve mainly as the rice granary of Japan proper. Oil occurs in some quantity in Sakhalin and Formosa, and great coal measures almost everywhere assure an ample supply of fuel for power production. On the other hand, the paucity of iron deposits in the Japanese Empire is a serious lack, bound to react in many ways on the national development. Japan, the author believes, will place less and less dependence, as time goes on, upon imports of raw materials other than iron, cotton, and foodstuffs. Hokkaido will probably in time be colonized on a large scale; but elsewhere the rôle of the Japanese must remain that of the *entrepreneur* and middleman.

The first seven chapters of Part II are devoted to India and Ceylon. Their climate, geology, orography, river systems, vegetation, and economics are described in detail, as are the regional differences and the reciprocating action of the northeast and southwest monsoons. In his discussion of the demography, the author points out the interesting fact that not the Himalayas themselves but the Terai, the marshy and malarious submontane strip of jungle stretching along their southern base, has acted as the ethnic boundary between Aryans and Mongoloids in this part of the world. In Chapter 16 he suggests that the much-discussed "westing" of the rivers in the Punjab may be due to nothing more than ordinary capture. He also notes that the density of population depends not merely on the rainfall but also on considerations of relief and on historical events.

Professor Sion draws a distinction between the character of the British dominion in India and that of modern Japanese colonization. The latter, he quite correctly points out, is fundamentally official; while the former, he tells us, was based on individual initiative. This was no doubt true in great measure; nevertheless the quasi-governmental nature of the old East India Company, with its own armies, fleets, fortifications, and administrative system, should not be forgotten. It is due, says our author, to development of the land routes and the abolition of interior customs barriers that India has developed a true economic unity. In this, as in most other ways, he thinks, British rule has been of vast benefit to that country.

Indo-China is no less adequately dealt with, a very good though necessarily condensed ethnographical and historical sketch of that region being given. Naturally the preponderance of space is devoted to the portions controlled by France, the remainder—Burma, Siam, and the Malay Peninsula—being all included within the limits of a single chapter.

The East Indian Archipelago, "Insulinde," forms the subject of three chapters. Professor Sion's account of the successive strata of population still to be found there is particularly good, as is his appraisal of the civilizing influences exerted by Hindus, Chinese, and Arabs in turn. To American readers the analysis of conditions in the Philippines, by such an independent and thoroughly competent observer, will be of especial interest.

In the concluding chapter is discussed the place of monsoon Asia in the evolution of humanity. The author remarks that it has been its climate above all that has given to this portion of the earth's surface the very real unity which it admittedly possesses. Here, however, he is perhaps running some risk of incurring the very danger against which he cautioned us in the first part, viz., that of overemphasis on geographical determinism. He devotes hardly enough attention to the fact that this part of Asia was overspread, well back in prehistoric times, by a generalized and in many ways strikingly uniform type of Neolithic culture which has afforded the basis for all later development. Hence the contrast he draws between this region and tropical Africa and America, where climatic conditions are similar but where this particular culture was absent, is perhaps not quite to the point.

In the concluding paragraphs are discussed the relations of the various portions of monsoon Asia with one another and with the rest of the world. Finally, Professor Sion treats of the prospects for the future, including the possibility of the rise of an "Asiatic peril." Regarding the latter he displays a considerable but probably not unjustified optimism.

Appended to the various chapters are well selected and up-to-date bibliographies, which, however, do not quite make up for the absence of footnotes giving more specific documentation. There are detailed tables of contents and a good index. The plates are admirably selected, well executed, and truly illustrative in the best sense. There are also statistical tables, maps in the text, and excellent double-page hypsometrical maps of Japan and Korea and of Indochina in colors.

CARL W. BISHOP

TROPICAL AUSTRALIA

CAPTAIN SIR G. H. WILKINS. **Undiscovered Australia: Being an Account of an Expedition to Tropical Australia to Collect Specimens of the Rarer Native Fauna for the British Museum, 1923–1925.** xiii and 353 pp.; map, ills., index. G. P. Putnam's Sons, New York and London, 1929. $4.50. 9 x 6 inches.

"Eyes belong you lookabout, see everything," said the Milingimbi natives of Captain Wilkins, whom they placed in a new category, "proper-white man," for he did not fit in with the "missionary" or "white man" (policemen, traders, surveyors, and stockmen) of their experience. This was while he was engaged in making a collection of the rapidly disappearing native fauna of Australia for the British Museum (Natural History) in the years 1923–1925, an interlude between Antarctic and Arctic exploration. The shrewd native comment is confirmed in the appendix of this volume which, referring to the scientific results, says "seldom has an exploring expedition been managed with such economy and carried out so exactly to plan."

Wilkins collected chiefly in Queensland on both sides of the Great Dividing Range, about the Gulf of Carpentaria, and in the northern part of Northern Territory. Perhaps the most interesting thing in his book, geographically speaking, is the picture he presents of the country from the standpoint of settlement, the more interesting in that this was not his specific purpose and that he views the question impartially. Darwin, a straggling town, in which "we first noticed the meanness which seems to permeate the northern part of Northern Territory"; barren areas of the Cape York peninsula, where the land about the Macmillan River, surveyed by Captain Wilkins, is "veritably a biological desert"; the lean country of the King

River district, whose natives practice "promiscuous cannibalism"; the deserted cattle station of Marumba (on the divide between the Roper and Goyder rivers; not shown on the accompanying and scarcely adequate map), whose holders had "long since given up the struggle with droughts and difficulties of transport." True, there are fertile lands in the north, but the necessary capital and labor are not likely to be attracted while there "still remain districts nearer the existing lines of communication which might develop with less initial expenditure and equally satisfactory results."

Wilkins testifies to the wonderful value of the rolling downs of central Queensland "even in abnormal drought conditions," but he is unfavorably impressed with the social and cultural status of the settlers. In the country they occupy poor makeshift quarters and mediocre dwellings on their retirement to the suburbs of the cities. "One of the most disappointing things to me as an Australian was to find that so many able-bodied men 'retired' from productive work with only just enough money for a bare existence. They form a leisured class without high culture and without the desires or inclinations that foster the development of art or learning." It is hardly surprising: Queensland had only three-quarters of a million population at the 1921 census: Brisbane, the metropolis, had some 210,000 inhabitants, and there were 180,000 more in the provincial towns—a slender thread of urban culture for 670,000 square miles of territory in this remote corner of the world.

A New Zealand National Park

James Cowan. **The Tongariro National Park, New Zealand: Its Topography, Geology, Alpine and Volcanic Features, History and Maori Folk-Lore.** iv and 156 pp.; maps, diagr., ills., index. The Tongariro National Park Board, Wellington, 1927. 8¼ x 5½ inches.

The Tongariro National Park is situated in the center of North Island of New Zealand, halfway between Wellington and Auckland, about 150 miles from each. It covers an area of almost 250 square miles, representing, however, only six per cent of the national park area of New Zealand, which totals over two and a half million acres. This is virtually one-third of the area of the national parks in the United States. It is perhaps fair to say that no other country of the world has so great a proportion of its area devoted to national parks and forests as New Zealand has. Not even the United States can boast so great a variety of physiographic and geological features so splendidly preserved in her public playgrounds.

Tongariro lies southwest of Taupo, New Zealand's largest lake. On the center of the prairie plateau that constitutes the park, in a line almost north and south, rest the three lofty mountains Ruapehu, Ngauruhoe, and Tongariro, which form the nucleus of the National Park, a gift to the nation from the paramount chief of the Taupo, Te Heuheu Tukino, forty years ago. These volcanoes, rising to heights of 7500 to 9000 feet, exhibit every range of volcanic phenomena: lava streams, steaming craters, sulphurous pits, boiling lakes, geysers, and fumaroles vie with glaciers and snow fields.

Mr. Cowan's book gives first a readable and easily understood general description of the park, followed by a history of the region and an account of the native legends and folklore. A chapter is devoted to a detailed description of each of the three great peaks, enlivened by reference to the pioneer ascents.

A chapter by Mr. B. C. Aston, President of the New Zealand Institute, describes the plant life, and there is a chapter on Maori place names. The final chapter gives facts concerning routes to the park, facilities for pleasuring, and accommodations for travelers and campers.

The book is excellently illustrated with photographs of the mountains and waterfalls, the various plants, and some of the historic characters; it also includes two

large maps showing in detail the configuration of the country. It is obviously designed for all sorts of readers, some of whom may be as much fascinated by early legends as by descriptions of natural phenomena. It has been written by one not unaware of the beauty and the romance of the country he describes.

A. K. Lobeck

An Atlas Handbook of the Italian Colonies

Mario Baratta and Luigi Visintin. **Atlante delle colonie italiane con notizie geografiche ed economiche.** xv and 87 pp.; maps, ills., index. Istituto Geografico de Agostini, Novara, 1928. 10½ x 7 inches.

Professors Baratta and Visintin are the authors of the "Grande Atlante Geografico" (Istituto Geografico de Agostini), the first edition of which appeared in 1922 and which has subsequently been published in second (1925) and third (1928) revised editions (see "Post-War Atlases: A Review," by W. L. G. Joerg, in *Geogr. Rev.*, Vol. 13, 1923, pp. 583–598). In this new work the authors have happily applied the concepts of their world atlas to the Italian colonies. The result is a timely and most convenient atlas handbook. The effective physico-political maps of Libya, Eritrea, and Somalia on the scale 1 : 5,000,000 have been reproduced with some revisions from the "Grande Atlante," and there are larger-scale sectional maps of the African possessions and a map of Italy's Aegean Islands on the scale of 1 : 1,000,000. The small-scale political map of Africa is brought up to date (1927) though the new boundary of Kenya Colony west of Lake Rudolf (see Colony and Protectorate of Kenya: Report for 1926, *Ann. Colonial Repts. No. 1352*, London, 1927) is not shown; and, of course, the Italian version of the Libyan-Anglo-Egyptian-Sudan boundary is given. The rainfall map of the "Grande Atlante" is reproduced; the vegetation map is revised.

The maps are preceded by a brief historical introduction and followed by a novel and valuable feature, 60 pages of rotogravure illustrations, including some interesting views of the great irrigation works in southern Somalia (compare Professor Dainelli's paper elsewhere in this *Review*). Then come 43 pages of concise geographical description.

Discovery of Africa in the Middle Ages

Charles de La Roncière. **La découverte de l'Afrique au moyen âge: Cartographes et explorateurs.** Vol. 1: **L'intérieur du continent,** viii and 175 pp.; maps, ills.; Vol. 2: **Le périple du continent,** 147 pp.; maps, ills.; Vol. 3: **Un explorateur français du Niger,** viii and 130 pp.; maps, index. *Mémoires Soc. Royale de Géogr. d'Égypte,* Vols. 5, 6, and 13. Cairo, 1925–1927. 14 x 11 inches.

In 1402 a French gentleman set out on a long journey into Africa. He went as far as the city of Gago, where he married a rich princess, and returned after eight years to Toulouse with his family and many blacks, amongst them being an eunuch named Aben Ali who was a great physician. According to M. de La Roncière the city of Gago is Gao on the Niger, and the language of the Turkish and African glossaries which the French gentleman, Anselme d'Isalguier, added to the description of his voyages is Tuareg. This information, taken from a contemporary chronicle, affords M. de La Roncière material for a charming "Idylle franco-nègre dans la boucle du Niger (1405–1413)," the opening chapter of his recently published third volume on the discovery of Africa in the Middle Ages.

It is corroborated by the portolano of Mecia de Viladestes of the same year 1413 which shows, for the first time, some true knowledge of Ahaggar and the towns of Tuat, Tamentit, and Buda. The lost manuscripts of Isalguier, when rediscovered, should speak the last word, of course, but other documents may be found to strengthen the theory. It is typical of M. de La Roncière. Those visitors to the Bibliothèque

Nationale who have been favored with a personal visit in his private room have enjoyed the tale of his discoveries in the history of Africa in all their first freshness with a wealth of detail and unexpected suggestions and new historical combinations.

M. de La Roncière's work, new in material and written in vivacious French style by a master of the language, calls for our admiration. It is full of details which, by being put in their rightful place, acquire importance hitherto unrealized. The author, however, has not merely filled a storehouse from his stupendous knowledge of original sources but has used them to help him trace new lines of investigation. Briefly he calls our attention to the general history of geographical discoveries, leading up to the discovery of America by Columbus. This event had its beginning many centuries before Christ, when people realized for the first time that the then known inhabited world was only a fourth part of the globe; the next step was the idea that the other three parts might contain dry land, perhaps even peopled by unknown men for whom names were invented. Those lands and peoples, however, could not be reached. In 1492 they were reached. Between these two points lie twenty centuries. Starting with the discovery of a very unusual fifteenth-century Portuguese portolan chart, in which he saw the hand of Columbus, M. de La Roncière evolved the theory that the discovery of Africa in the Middle Ages was one of the last phases of this long history. The map attributed to Columbus bears no name or date and had never been examined before M. de La Roncière found it. We must give him the right to conceive his theory and see how he proves it. He states in his third volume that the number of adherents to the theory is constantly increasing. Even if one does not agree with the identification of the map, he must admit that the theory has been and will be very fruitful.

In his third volume he gives the full development of his ideas: depreciation of money value through the Hundred Years' War, hence the desire for a gold standard, leading to the search for gold by the Genoese merchants, Columbus being one of their commercial travelers! I hear from M. de La Roncière that they are searching the records of the notaries for the history of the famous house of Centurione.

The work as a whole, so rich in material that it may be called a program for the geographical history of Africa from Greco-Roman times to the end of the Portuguese epoch, will prove the best guide to the reviving study of African history, and thanks are due to H. M. Fuad I, King of Egypt, for his august patronage and the encouragement given to these researches.

The first volume treats of "L'intérieur du continent." In a short, but fully documented, chapter the knowledge we have of the old Roman cartography is surveyed and the influence of the Arabs revealed. The origin of the portolan map (thus named by Nordenskiöld) is ascribed to the Genoese, and its first mention is fixed at 1270, when a map was produced on the sea voyage of St. Louis. As all its derivatives mention Kaffa (=Feodosia), a Genoese colony founded in 1266, it cannot be much earlier. La Roncière hazards a theory in regard to its author and calls attention to the name of Zaccaria, on the Black Sea coast in a thirteenth-century portolan chart. This name may indicate a trading post of the Zaccarias of Genoa.

It was not until the thirteenth century that Cape Blanco was reached by the Arab Ibn Fatima, and the Genoese expedition of the Vivaldi reached Somaliland in 1291 on the way to the mysterious Christian prince Prester John. His name may be derived from the Amharic title Zan or Gan for Majesty, and his first appearance in history is between 1165 and 1177. The Red Sea was visited in 1182 by five French galleys.

On the oldest portolans and portolan charts echoes of these enterprises and explorations are observed, and real value is given to names and pictures which have perhaps been too much considered as phantasies and ornaments.

The chapter devoted to the knowledge of the Sahara in antiquity and in the Middle Ages is of absorbing interest. Few people have realized how much was known of

these regions, and the picture La Roncière gives of the caravan routes and of the flourishing cities which are now "villes mortes" is seductive. Here the author comes to one of his special points: "l'ère juive du Sahara" and the connection between the cartographers of Majorca, the Cresques, Mecia de Viladestes, Gabriel de Vallsecha, and their Jewish kinsmen in the Sahara. The famous Catalan atlas of 1375 is attributed to Abraham Cresques.

The Sudan was visited by a European for the first time before 1283, according to the report of Raymond Lull. An Andalusian architect, Tueïdgine, commissioned to build a palace in Timbuktu, died there in 1346. A manuscript discovered by the author revealed the first description of Tuat in 1447 by a European eyewitness, Antonio Malfant. Timbuktu was again visited by the Florentine, Benedetto Dei, in 1470, and by the French navigator, Paul Imbert, in 1618.

This knowledge of interior Africa laid down on the medieval portolan charts was not, however, reproduced by later cartographers and was hence forgotten.

In the second volume the Portuguese circumnavigation is preluded by references to the "Fortunate Isles," which are identified as the Azores and the Canary Islands, visited in 1341 by the Genoese, Niccoloso di Recco, and the Florentine, Angelino del Tegghia. Several visits to the Canary Islands by Spanish and Italian ships are well established by contemporary documents. For the French factories on the coast of Guinea in the fourteenth century, the reference is as late as the book of N. Villault de Bellefond, "Relation des costes d'Afrique appelées Guinée," which appeared in 1669. The archives of Dieppe were burnt in 1694, so this account cannot be verified by original documents. "Ah! l'irritant problème!"

The last chapter of the periplus is of special interest. It relates visits of Europeans to Egypt in the Middle Ages, summarizes what was done during that epoch to discover the sources of the Nile, and gives full information on European ambassadors and artists in Abyssinia. It culminates in the large world map of Fra Mauro in the Doges Palace in Venice. This map has been dated 1457 or 1459. M. de La Roncière found that in 1811, when the map was removed from San Michele de Murano to the Marciana, an inscription at the back revealed that it was completed in 1460.

The work is accompanied by 40 plates, mostly of the African portions of medieval maps very well reproduced and quite readable.

F. C. WIEDER

A CHAPTER IN THE HISTORY OF COMMUNICATIONS

H. L. HOSKINS. **British Routes to India.** xiii and 494 pp.; maps, ills., index. Longmans, Green & Co., New York, London, Toronto, 1928. $7.50. 9¼ x 6½ inches.

For over two and a half centuries after the East India Company received its charter in 1600 the main line of communication between Great Britain and India was by sea around the Cape of Good Hope. There were good reasons why the more direct natural routes leading from the eastern Mediterranean through the Red Sea and through Mesopotamia and the Persian Gulf were not used. Each of these routes necessitated a passage by land across difficult desert country where the traveler and his goods were at the mercy of roving Bedouins. Uncharted coral reefs and fickle winds in the Red Sea, the southwest monsoon on the Indian Ocean, and pirates in the Persian Gulf constituted serious dangers to navigation by sail. Furthermore, the Turkish government looked with jealousy and suspicion on Christian intruders. All in all, the hardships of the Cape voyage were insignificant as compared with those of a journey by the direct routes, and the shipment of freight in bulk by the latter was entirely out of the question. As a consequence, before the opening of the last century Great Britain was not particularly concerned with the possibility of developing these routes or with the political situation in the portions of the Near East through which they pass.

Before the middle of the nineteenth century, however, a great change was well under way. The invention of the steamship, the railroad, and the telegraph demonstrated that the establishment of more direct lines of communication was entirely practicable. Turkish prestige was crumbling, and the relatively progressive house of Mehemet Ali was in control of Egypt. The British government had put down piracy in the Persian Gulf, and the coral reefs of the Red Sea were being charted by British hydrographers. De Lesseps was pushing his plans for a canal through the Isthmus of Suez, and the possibility of rail and water transport by way of Syria, the Euphrates, and the Persian Gulf was the subject of serious consideration on the part of the British government. In India the constant increase in the number of British officers and civilians and the enlargement of British administrative responsibility formed additional stimuli to the search for a more rapid and convenient route than that taken by sailing vessels around Africa.

In the scholarly volume under review Dr. Hoskins tells the story of the establishment of steamship and telegraphic communication between Great Britain and India by the routes through the Mediterranean and Near East. In its early stages, particularly before the completion of the Suez Canal, this is a story of slow and halting progress. Innumerable false starts were made, and failure was as frequent as success. Physical obstacles of a type that we now tend to forget had to be overcome. For example, the horrors of the plague which often infested the ports of Egypt and Syria "were unquestionably one of the most potent factors in delaying the actual opening of either of the shorter land passages in conjunction with steam lines." Ocean-going steamers of the twenties, thirties, and forties consumed an inordinate amount of coal for the power developed. Similar difficulties attended the earlier efforts to establish telegraph lines. An attempt was made in 1859 to lay a cable from Suez to Aden as a link in the line from Constantinople to Karachi. In the course of this work it was found that the "surveys made of the floors of the Red and Arabian Seas were very inadequate." As a result, the cable had to be "laid by compass without any attempt to select a bed of uniform depth, and the cable itself was not equally well adapted to various water temperatures and ocean topography. . . . The protective wire wrappings of the line quickly disintegrated in the warm salt water of the Red Sea." This, combined with the destructive work of marine borers, sharks, tidal currents, and sharp rocks all led to the complete failure of the enterprise.

These random examples of physical difficulties illustrate some of the many points of distinctive geographical interest brought out by Dr. Hoskins. Obstacles of this sort, however, have had to be overcome in the creation of every effective system of communication and constituted by no means the most serious difficulties encountered by the promoters of British lines of transportation to and communication with India. The growth of such lines of communication has at all times been conditioned by much larger political issues. One of the most valuable qualities of Dr. Hoskins' book is that the more intimate account of the building up of steamship and telegraph routes is clearly presented against this broader political background.

A Treatise on Czechoslovakia

Fritz Machatschek. **Landeskunde der sudeten- und west-Karpatenländer.** xi and 440 pp.; maps, diagrs., ills., bibliogr., index. (Bibliothek Länderkundlicher Handbücher herausg. von Albrecht Penck.) J. Engelhorn, Stuttgart, 1927. Rm. 30. 9 x 6 inches.

Every geographer who desires a fundamental understanding of Czechoslovakia and critical adjacent territory will wish to acquaint himself with Machatschek's admirable treatise. The author has lived in the region for many years and has first-hand knowledge of every part of it. The reviewer has walked through diverse

parts of the region and is impressed with the thoroughness of this presentation. For source material the volume is a mine. A bibliography of 945 titles almost staggers one; yet Machatschek modestly says that, while he has not included all available titles, he hopes that none of the more recent important discussions has been overlooked. Numerous tables, maps, and illustrations illuminate the treatise.

The author divides the book into two parts—the first presenting the territory from the viewpoint of its political composition, and the second according to twelve major natural regions. The second part is the more strictly geographic. The first part frequently includes material of a purely economic or political character but indispensable to a well balanced geographic interpretation.

The volume contains many subjects that invite discussion. A few points only may be touched upon here. The elongate character of Czechoslovakia is pointed out as unfavorable to the effective development of the country as a unit, although it serves well as a connecting link between highly developed, densely populated central Europe and the industrial, raw-material region of the Poles, Magyars, and Rumanians. It assumes a bridgelike character between advanced western Europe and backward eastern Europe.

An unexpected conflict between national well being and the sudden acquisition of a surplus in natural resources is strikingly illustrated. As a part of Austria-Hungary, this region produced three-quarters of the coal, three-fifths of the iron ore, and an average of four-fifths of the manufactures. With the establishment of the republic immediate prosperity did not arise, for the purchasing power of vast numbers of persons was curtailed in all the contiguous territory, which had now become foreign in relation to Czechoslovakia. The latter's relative gain in resources was offset by the former's loss and consequent decline in wealth. Furthermore, new tariff walls restricted exports. While the effect upon Czechoslovakia was temporary, it at first was somewhat of a shock which the people had not anticipated.

Professor Machatschek shows here and there some bias in favor of the German element. His use of the German form of geographic names, when they are no longer official in Czech circles, is open to question. Shall we insist that the capital be called *Prag* when its citizens have decided upon *Praha*, a word no more difficult to spell or pronounce?

The Czech-German language fight and the historical background of present political, social, and religious settings are all effectively presented. These humanistic aspects are preceded by a discussion of the physical environments in which they have been evolved.

EUGENE VAN CLEEF

NIAGARA FALLS AND GORGES

W. H. BOYD. **A New Method of Determining the Rate of Recession of Niagara Falls.** Diagrs., ills. *Trans. Royal Soc. of Canada*, Vol. 22, 1928, Sect. 4, pp. 1–12.

W. A. JOHNSTON. **The Age of the Upper Great Gorge of Niagara River.** Map, diagrs. *Ibid.*, pp. 13–29.

The Falls of Niagara were surveyed in 1841–1842, 1875, 1886, 1890, 1904–1905, 1905, 1906, 1911, 1917, and 1925. In 1927 they were mapped for the eleventh time by Boyd after a phototopographical method. Surveying camera pictures were taken simultaneously from three stations of the same portion of the falls, so that identification of points—the difficulty encountered in previous surveys—became an easy matter. The mean annual rate of recession of the Horseshoe Fall from 1842 to 1905 is found to be 3.8 feet and from 1905 to 1925 2.3 feet. The retreat of the American Fall was calculated by G. K. Gilbert at 0.2 foot per annum; but the fall has apparently undergone no recession since 1895.

Johnston's paper deals with two separate problems, viz. the age of the Upper Great Gorge of Niagara and the time of formation of the Whirlpool Rapids Gorge. Formation of the Upper Great Gorge, which is now 2¼ miles long, began when the Upper Great Lakes for the last time started to drain through Lake Erie and the Niagara River. Boyd's new figure of 3.8 feet as the mean rate of recession of the Horseshoe Fall, instead of Gilbert's figure of 5 feet, makes it probable that the cutting of the gorge represents some 4000 years, instead of 3000 to 3500 years as held by F. B. Taylor.

In 1899 two borings and in 1919 17 borings were carried out by the Michigan Central Railroad Co. at the upper of the two railroad bridges across the Whirpool Rapids near the lower end of the Upper Great Gorge. They show that there is a filling of unconsolidated materials to a depth of about 100 feet below the present bed of the river. On the logs of the borings this material has been divided by Johnston into talus and glacial drift—and there is little doubt that it really is glacial drift. The presence of drift in the bottom of the gorge shows that the whole of the Whirlpool Rapids Gorge, including the Whirlpool, is an old gorge filled with glacial drift and reëxcavated in part by the postglacial Niagara River. This view is radically different from the old one that the gorge was formed by recession of the falls in postglacial time during the Nipissing Great Lakes stage, when the Upper Great Lakes were drained through the Mattawa-Ottawa valleys. During the last-mentioned stage only reëxcavation of the gorge, which seems to have been accomplished by a much smaller stream than the present one, may have taken place.

The drift-filled Whirlpool Rapids Gorge may have been already cleaned out to some extent when the lower late-glacial gorges were formed. When the Lower Great Gorge had extended up to the Whirlpool, a fall eventually began to form at the upper end of the interglacial Whirlpool Rapids Gorge. But this again would mean that the Upper Great Gorge would have started forming at the beginning of or in the early part of the Nipissing Great Lakes stage and that there would be no difference in width between the Nipissing Great Lakes gorge and the gorge formed after modern conditions were established.

The Whirlpool, as is well known, forms the upper part of an interglacial drift-filled channel, the St. David Gorge, extending northwestward to Lake Ontario. The much greater depth of the Whirlpool and the Eddy Basin, the expansion just above the Whirlpool, than of the Whirlpool Rapids may mean a considerable change of level in relation to Lake Ontario. The change in width of the canyon at the same place may mean a change in the volume of the water. The St. David Gorge and the Rapids Gorge date perhaps from different interglacials.

While the Upper Great Gorge may represent about 4000 years, "the age of the Niagara Gorge as a whole cannot be determined, for there is no way of telling the rate of formation of the Whirlpool Rapids Gorge nor of the lower gorge reaching from the Whirlpool to the escarpment at Queenston."

ERNST ANTEVS

HISTORY OF THE MOUNTED POLICE OF CANADA

T. MORRIS LONGSTRETH. **The Silent Force: Scenes from the Life of the Mounted Police of Canada.** xiv and 383 pp.; maps, ills., index. The Century Co., New York, 1927. $4.00. 9 x 6 inches.

Mr. Longstreth's history of this famous police force, is written, it must be confessed, in something of its spirit, although adherence to actual events necessarily curbs any fantastic flights. For a knowledge of these events he was able to draw on the records of the police headquarters; for their interpretation he consulted its officers, lived at some of its barracks, and traveled from one end of Canada to the other.

He traces the history of the force from its birth in 1873, explaining clearly how what was in earlier days a semi-military organization designed to keep peace on the prairies gradually developed into a super-police and detective force operating in all parts of the Dominion. No attempt is made to place this development in its proper setting, to outline the spread of settlement west and north, the rapid growth of the various provinces, and the tremendous increase in population, production, and trade. Instead, the book assumes the character of a regimental history. In spite of its brief career, however, the "Force" has gained a record of which every Canadian is justly proud, and Mr. Longstreth has done a real service in setting forth that record for the inspection of all the English-speaking world. If he waxes a little overeloquent in places, as when he describes the Winnipeg riot of 1919, we feel inclined to condone it because no one can steep himself, as he has done, in the records of the Mounties without becoming an enthusiastic partisan. His book recalls or rescues from oblivion many stirring deeds, some of which, like the guarding of the Chilkoot Pass during the Yukon gold rush, deserve to find a place in every Canadian history. But on the whole its appeal is to the general public and to historians, rather than to geographers. One may draw attention, perhaps, to some of the northern patrols undertaken during the last few years—Inspector French's journey, for example, from Baker Lake to Bathurst Inlet on the Arctic coast, and Sergeant Wight's trip across the south of Baffin Island. There is new and interesting geographical information in the published accounts of both these journeys. And one may regret in closing that the author could not record the most remarkable patrol of all, Sergeant Joy's exploration of Ellesmere Island and other parts of the far northern archipelago in the winter of 1926–1927.

D. JENNESS

NORTH AND EAST GREENLAND

LAUGE KOCH. **Nord om Grønland.** 279 pp.; map, ills. Levin & Munksgaard, Copenhagen, 1927. 10 x 7 inches. French translation, "Au nord du Groenland," by Margrethe Trock.

KNUD RASMUSSEN. **Report of the II. Thule-Expedition for the Exploration of Greenland from Melville Bay to De Long Fjord, 1916–1918.** Maps, ills. *Meddelelser om Grønland*, Vol. 65, 1928, pp. 1–180.

LAUGE KOCH. **Contributions to the Glaciology of North Greenland.** Maps, diagrs., ills., bibliogr., index. *Meddelelser om Grønland*, Vol. 65, 1928, pp. 181–464.

LAUGE KOCH. **Two Recent Journeys on the Coast of Eastern Greenland.** Map, ills. *Geogr. Journ.*, Vol. 71, 1928, pp. 1–15 (discussion, pp. 13–15).

GUNNAR ISACHSEN. **Grønland og Grønlandsisen.** 248 pp.; maps, ills., index. J. W. Cappelen, Oslo, 1925. 9 x 6¼ inches.

Lauge Koch first visited Greenland in 1913; he took part in Knud Rasmussen's expedition of 1916–1918; and in 1920 he started on his own expedition to North Greenland. After spending the winter on Inglefield Gulf (77½° N., 71° W.) at the northwestern corner of Greenland he set out on a journey that took him and his Eskimos over the frozen fiords and glaciers around the north coast of Greenland, down the east coast of Peary Land, and over the northern part of the land ice back to the starting point, which was reached at the end of September. After wintering at Tasiusak and Upernivik in 1922 he undertook journeys to the 82nd parallel and to Humboldt Glacier for geological studies. After another winter in Upernivik, in the spring of 1923 he mapped the Cape York District.

"Nord om Grønland" is a colorful description of events, of storms, of hard travel over pack ice and crevassed glaciers and through icy water, of hunger and fantastic hunger dreams, of subsistence for weeks on the meat of starved dogs and loss of dogs

by starvation and exhaustion, of wild joy and feasts when the hunt had been successful.

Volume 64 of the *Meddelelser om Grønland*, published in 1927, contained thirteen papers presenting some of the scientific results—cartographical, hydrographical, biological—of the Second Thule Expedition, 1916–1918. In the first part of Volume 65 we have the general account of the journey by the leader, Knud Rasmussen (compare *Geogr. Rev.*, Vol. 8, 1919, pp. 116–125, 180–187). In the second part Lauge Koch discusses the glaciology of North Greenland on the basis of the data collected during the Second Thule Expedition and during his later journeys in the region (see above). Some observations made on his expedition to East Greenland in 1926–1927 (see below) have also been utilized.

Precipitation, which is almost exclusively in the form of snow, amounts to less than 100 millimeters. In consequence there are extensive ice-free areas along the coasts, and the snow line lies at the remarkable altitude of from 500 to 1250 meters. The summer temperature is comparatively high. Comparisons are made with the glaciers and inland ice of the Antarctic.

With the exception of glacier ice formed on the sea, all the types of glaciers defined by R. E. Priestley in the Antarctic are represented in North Greenland, though they are generally not well developed.

The land ice in North Greenland rests on a low and rugged rock surface by which its contour is markedly affected. It does not reach the sea except through glaciers ending in the fiords. The edge of the ice sheet has been stationary at any rate during the last hundred years and probably for several hundred years. On the other hand some of the glaciers undergo oscillations.

During the ice age the whole of North Greenland, with the exception of the northern half of Peary Land, Northumberland Island (?), and several steep nunataks, was covered by the ice sheet.

In the postglacial age the shore line on the north coast for a time stood as much as 210 meters higher than today. With a single exception none of the glaciers whose front now lies near the 210-meter level has been farther advanced since the maximum of the subsidence.

In 1926 the Danish government financed Lauge Koch's expedition to the east coast of Greenland with the Eskimo colony on Scoresby Sound as its base. The prime object was a geological survey of the coast. In addition an economic survey was undertaken, and the expedition fulfilled a requirement of the treaty of 1923 between Denmark and Norway by visiting the hunting stations of the East Greenland Company, for "if the houses are not officially surveyed every five years the possession would be lost—this particular part being 'No Man's Land.' " Two long sledge journeys were made, one in November to Hold with Hope (latitude 74° N.), the other in the spring of 1927 to Denmark Harbor (latitude 76° 40′ N.).

Major Isachsen's book deals largely with experiences in the ice on the east coast of Greenland in 1923 and 1924. Told in diary form it gives a graphic idea of conditions in that difficult area.

In 1923 the *Conrad Holmboe* sailed to relieve the observers at the Norwegian radio station of Myggbukta, a little north of Franz Josef Fjord. The ship was caught in the ice and drifted for about two months. She eventually got away and went down to Iceland, almost a wreck. Another ship, the *Polarulv*, sent out to rescue the *Holmboe*, was wrecked in the ice with the loss of four men. The same summer two other ships, the *Anni* and the *Teddy* were lost in the ice off East Greenland. When nothing was heard from them in the spring of 1924 a rescue expedition was sent out and found the crew of the *Teddy:* the *Anni* and her crew were never found.

In the last chapter the author criticizes the agreement between Denmark and Norway concerning the right to hunt and fish on the east coast of Greenland. Texts relative to the agreement are given in the appendix.

ERNST ANTEVS

Air Pioneering in the Arctic

Air Pioneering in the Arctic: The Two Polar Flights of Roald Amundsen and Lincoln Ellsworth. 126 pp.; maps, ills. National Americana Society, New York, 1929. $35.00. 14 x 11 inches.

"From first to last the history of Polar exploration is a single, mighty manifestation of the power of the Unknown over the mind of man." If illustration of Dr. Nansen's often-quoted words be wanted it may be found in "Air Pioneering in the Arctic" with its photographs so exquisitely reproduced, with such skillfully caught "atmosphere," that it is impossible not to be profoundly affected by them. Look, for instance, at No. 12, Part I, the N 25 "like a gnat in an ocean of space just before landing 600 miles into the unknown"; or No. 13, "a forced landing 136 miles from the north pole"; or No. 22, Part II, "first human vision of the 'great unknown' lying between the north pole and Alaska." And who could fail of response to the sight of the "first land after 2000 miles—the coast of Alaska" (No. 25)?

In "Air Pioneering in the Arctic" Mr. Ellsworth has brought together material from various sources—including selected portions of "Our Polar Flight" and "The First Crossing of the Polar Sea"—to tell vividly the adventures into the unknown that he shared with Amundsen in 1925 and 1926. Appropriately the volume concludes with his deeply-felt tribute to the lost comrade, the "supreme adventurer." On the geographical aspects of the pioneer flights of 1925 and 1926 reference has been made in the *Geographical Review* (see Vol. 15, 1925, pp. 665–667 and Vol. 16, 1926, pp. 662–665); here it suffices to repeat that they were doubly penetrations of the unknown—in space and technique.

On the Polar Regions

R. N. Rudmose Brown. **The Polar Regions: A Physical and Economic Geography of the Arctic and Antarctic.** ix and 245 pp.; maps, bibliogr., index. Methuen & Co., Ltd., London, 1927. 12s. 6d. 9 x 6 inches.

A. W. Greely. **The Polar Regions in the Twentieth Century: Their Discovery and Industrial Evolution.** x and 270 pp.; maps, ills., index. Little, Brown & Co., Boston, 1928. $4.00. 9 x 6 inches.

J. Gordon Hayes. **Antarctica: A Treatise on the Southern Continent.** xv and 448 pp.; maps, diagrs., ills., bibliogr., index. The Richards Press, Ltd., London, 1928. 42s. 10½ x 7½ inches.

The recent progress of polar exploration and our changing attitude towards the polar regions is well illustrated by these three books. Dr. Rudmose Brown states in his preface that his study "is not confined to physical and biological geography, but deals at some length with the growing commercial and political penetration of polar regions and the colonization of land in high latitudes," and General Greely that his aim is to show the "increased utilization of the material resources of the polar regions."

Dr. Rudmose Brown's book appears in Methuen's Geographical Series, which already had to its credit excellent volumes on North America (by L. Rodwell Jones and P. W. Bryan) and South America (by E. W. Shanahan), and maintains the high standard set. Its author is eminently qualified for the task. He has had personal experience in both Arctic and Antarctic; he has written extensively on many phases of these regions; he is a teacher of many years' standing. His book is well balanced as well as authoritative; and, more, possesses that supreme virtue of a textbook of being concise without sacrifice of clearness and accuracy. The arrangement follows the usual convention. The titles of the chapters dealing specifically with the human elements are: The Eskimo; Whaling: North and South; Political Geography;

Trade Routes; Colonization (Greenland and Novaya Zemlya, Spitsbergen, the Canadian Archipelago); Hygiene. One small grievance: in the bibliographical appendix it is said there is "no attempt at completeness" but it is a little annoying to find in the text a reference to the interesting work of C. H. Pollog (p. 40) without a clue to the source (Untersuchung von jährlichen Temperaturkurven zur Charakteristik und Definition des Polarklimas, *Mitt. Geogr. Gesell. in München*, Vol. 17, 1924, pp. 165–253).

General Greely's "Handbook of Polar Discoveries" (5th edit., 1910) has long been a standard work. In "The Polar Regions in the Twentieth Century" he has condensed that history and brought it up to date as the basis of an account of the occupation and utilization of these regions. The Arctic naturally has the lion's share: but the 40 pages allotted to the Antarctic might well have been expanded to give a more adequate idea of the whaling industry here dismissed in a few words. Where condensation is so great it is not surprising to find errors of implication if not of actual fact, for example, the partial statement of conjectures as to the fate of the early Norse settlements in Greenland (p. 94) and the somewhat misleading remark on the Eskimo settlements on the east coast (p. 103), of which until the foundation of the Scoresby Sound colony in 1925 Angmagssalik had for a long time past been the only survivor. The scientific work of Norwegians in Spitsbergen, as Dr. Adolf Hoel protests, is not acknowledged, and there are not a few errors of proof reading, for example, the longitude of Jan Mayen, p. 105; the date of the "Times Book of Russia," p. 164. But General Greely has brought together a suggestive array of facts on the exploitation of the lands beyond the Arctic Circle.

Mr. Hayes's "Antarctica" is a rather curious book. Its purpose is to treat of Antarctica "as fully as possible" . . . "to treat the subject somewhat scientifically, without undue technicality, the standpoint being that of an ordinary educated reader rather than that of a specialist." The author has had no experience in the regions he discusses, and his study is confined for the most part to such narratives of Antarctic expeditions as are available in English. Withal he has produced a work of real value; within the limitations described he has gone deeply into the subject, and he shows good judgment in the selection and analysis of material. Moreover his book is readable. For a critical analysis of its merits and defects reference should be made to Dr. H. R. Mill's discussion in the *Geographical Journal* (Vol. 72, 1928, pp. 63–66). One feature of the book needs emphasis—the quite exceptionally full index. The index, indeed, makes the book an indispensable tool to the serious student as well as the "ordinary educated reader."

A Meteorological Treatise

W. J. Humphreys. **Physics of the Air.** 2nd edit., revised and enlarged. xii and 654 pp.; diagrs., ills., index. McGraw-Hill Book Co., Inc., New York, 1929. $6.00. 9 x 6 inches.

The first edition of this indispensable book appeared nine years ago (see review by Alexander McAdie in *Geogr. Rev.*, Vol. 11, 1921, pp. 157–159). Much has happened to meteorology since then, and nobody has taken a more active part in bringing about its transformations than the author of the work under review. The second edition contains not only one entirely new section—on Atmospheric Acoustics—but also a great amount of new material scattered throughout. Its text is actually more than twenty per cent longer than that of its predecessor, despite a reduction in both the size and the number of the pages. Smaller type has been used, and the proportion of white paper to printed matter has been diminished to the verge of parsimony.

Dr. Humphreys, as most meteorologists and physicists are aware, is a shining example of the scientific expositor whose motto is that of the Royal Society of

London—*nullius in verba*. He takes nobody's word for anything. The statements found in "Physics of the Air" are there, not because they have appeared in previous books on meteorology, but because each and every one of them has passed the test of a critical review by the author. By the same token, much familiar misinformation that had been passed on from one meteorological writer to another for years or generations is conspicuously absent from Humphreys' treatise.

Within the limits indicated by its title the book is complete and self-contained. Much subsidiary information is made accessible by copious references, but the essential facts are here. The explanations are fully checked by calculations and mathematical reasoning, but this fact does not militate against the use of the book by non-mathematical students and readers. It would, for example, be quite feasible for high school teachers to use selected portions of this work as the basis of an elementary course in meteorology; and until Dr. Humphreys gives us a long-awaited introductory textbook on the subject no other work can be so highly recommended for this purpose.

C. F. TALMAN

AN ATTACK UPON THE GULLY

J. RUSSELL SMITH. **Tree Crops: A Permanent Agriculture.** xii and 333 pp.; maps, diagrs., ills., bibliogr., index. Harcourt, Brace & Co., New York, 1929. $4.00. 9 x 6 inches.

Professor Smith has for many years been the apostle of tree agriculture both by word and by deed. He has written many articles on the subject, among which may be recalled that exceptionally interesting paper "The Oak Tree and Man's Environment" in Volume 1 (1916) of the *Geographical Review*. In the present work he brings together the results of his own experiences and travels—in the Mediterranean and the Far East in particular—a large correspondence, and much study. Here is the problem. Over large areas in New England and the Appalachians "the hills are gullied. The fields are barren. Tenantless houses, dilapidated cabins, tumbledown barns, poor roads, poor schools, and churches without a pastor—all are to be found in too many places." Professor Smith has a vision of these desolate hills become a green and pleasant and profitable land. His book is "primarily an attack upon the gully." Where land is too steep or rocky or arid for continuous successful cultivation of annual crops, that cultivation should be replaced by a permanent tree agriculture.

The major part of the volume presents "some facts about some crop trees," principally on their value in providing stock foods. It embraces the *keawe* or Hawaiian algaroba, carob, honey locust, mesquites, mulberry, persimmon, chestnut, oak, walnuts, hickories, and there is a "peep at the tropics." There follow sections on farm management and an appendix with a good deal of practical advice. Shift from the grain type of agriculture to the crop-tree type would ideally be approached through an institute or institutes of mountain agriculture, where expert selection could be made of trees, native and foreign, and studies of breeding, soil erosion, etc. carried on. Meanwhile here is an inspiration for the individual farmer who can begin gradually to transform his practice; for Professor Smith is no revolutionist but the advocate of a sober and considered policy.